

# **COMBAT RATION NETWORK FOR TECHNOLOGY IMPLEMENTATION**

## **Manufacturability of Heat and Serve Ration in Institutional Pouch “System Analysis”**

**Final Technical Report STP#2019**

**Results and Accomplishments (May 2005 – September 2006)**

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#### Abstract:

The recent conflict in Iraq has shown that the surge capability of the H&S ration is limited and that either additional packaging equipment for the polymeric tray is required or that supplemental packaging systems need to be approved for use in the H&S ration during surge. Supplemental production capacity to the current poly tray industrial base capacity is an urgent program and of great importance to the Military Services, especially since polymeric tray production capacity seems to be shrinking. For this reason, the Institutional Pouch has created interest.

This report analyses the Unitized Group Rations and Surge Requirements for both the polymeric tray as well as the #10 can, and reviews the major pieces of equipment necessary to produce the items in a Institutional Pouch. A cost benefit analysis was performed using a methodology that evaluates "difficult to quantify" criteria and determined that there are significant benefits to the use of the ISP by the soldier and justifies the higher acquisition cost of this ration in ISP over a #10 can.

This original scope of the project was to execute manufacturability studies on the ISP and develop a knowledge base that could be used to increase the manufacturability of the ration and lower the cost. Funding for these additional phases was not released.

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# 1 Results and Accomplishments

## 1.1 Introduction and Background

The recent conflict in Iraq has shown that the surge capability of the H&S ration is limited and that either additional packaging equipment for the polymeric tray is required or that supplemental packaging systems need to be approved for use in the H&S ration during surge. Supplemental production capacity to the current poly tray industrial base capacity is an urgent program and of great importance to the Military Services, especially since polymeric tray production capacity seems to be shrinking. For this reason, the Institutional Pouch has created interest.

The Institutional Pouch for military rations is new and not yet part of the military distribution system. As past experience has shown, the introduction of a new package is not trivial and requires careful planning and analysis of the entire system. Many decisions need to be made regarding pouch dimensions, pouch material, secondary packaging, product specification, package specification, etc. All of these decisions need to be carefully weighed against the impact on the process capacity, process efficiencies, process yields and the economics of manufacturing. Before these decisions can be made, a knowledge base that correlates the various aspects of the system must exist. This project proposed to build this knowledge base for the military institutional pouch and make it available to the Industrial Base. The Industrial Base could then make informed decisions on the use of existing assets versus capital investment, production setups, etc., as well, as additional investments required to support surge.

Allied Development Corporation, under a contract with Natick, performed an economic analysis in 2002 comparing the manufacturing cost of ISP versus #10 can containing fruits and vegetables. That study concluded that the food manufacturers pricing would increase approximately 12 – 18% for the ISP compared to the same product in a #10 can. Two production cases were compared: “Whole Kernel Corn” and “Sliced Peaches”. In both cases, the variable cost decreased for the ISP case but the fixed cost per pouch increased due to the 50% lower anticipated line speeds (25 pouches/min versus 50 cans/min). While the Allied report focused on replacing the #10 can by ISP, the Government's interest for the ISP application broadened. It is now also considering ISP as a supplemental container system for the Heat and Serve Ration during surge, at which time production capacity in polymeric trays falls short of demand.

Currently, the H&S ration is produced by only one company. Two companies dropped out in 2004 due to the limited commercial and/or military demand during peace time for polymeric tray rations and the difficulty meeting the stringent military specification for this product. The capacity of the remaining production line is more than adequate to meet peace time production requirements. However, surge requirements are a factor 10 times higher than peace time requirements and the capacity of a single packaging line is insufficient to produce “Just in Time”. This leads to inventory build up before the start of the hostilities and the need for the Government to identify supplemental production capacity in alternate containers.

At the time of the Allied report, only Truitt Brothers in Oregon was identified as a producer of retortable institutional pouches. Since that time, additional ration producers have acquired the capability to package products in vertical preformed institutional pouches for commercial reasons. However, vertical pouches are typically used for pumpable products such as “stews” and are not well suited for placeable products such as “ham slices”.

Under the DLA ManTech program for rations, Horizontal Form Fill and Seal (HFFS) technology was developed as an alternate packaging technology for placeable MRE's. The HFFS technology could potentially, also be used to package placeable products in an ISP container. The CORANET Demo Facility at Rutgers University has a Tiromat 3000 Horizontal Form Fill Seal machine that has the capability to form a 300mm x 380mm x 50mm pouch that can contain up to

7.0 lbs of product. In addition, the Government owns six Multivac HFFS lines for MRE's that could potentially produce ISP's.

## **1.2 Objectives**

The objective of phase I of this project was to conduct a systematic analysis of the Heat and Serve ration system, determine how it fits within the Unitized Group Ration system and what roll the Institutional Pouch can play in meeting the Surge Requirements. This data analysis was going to form the basis for the subsequent tasks. In a subsequent phase, the project would conduct manufacturability studies on the Institutional Pouch and document the impact and interaction of package and product specifications on manufacturability. This data would then be used for an economic analysis of the system and determine the sensitivity of critical variables such as product fit, packaging line speeds and retort cycle time and give guidance to the Industry for capital investment.

Due to commercial developments of ISP, funding was, however, limited to the phase I activities, and the development and optimization of the ISP is being left up to the commercial producer.

## **1.3 Results and Conclusions**

The Allied Report recommended that a development program would be required in order to implement ISP in the United States. One of the major reason that they quoted was the need to increase and optimize line speeds of the filling and sealing equipment as well as optimizing the retort cycle times in order to bring the cost down.

Analysis of current packaging systems for ISP reveals that packaging line speeds have increased. Both Fres-co and Toyo Jidoki (TYJ) have lines that exceed the rates mentioned in the Allied report and two of these ISP line could meet the H&S surge requirements for pumpable products.

Pouch sizing is a key component in the manufacturability of the ISP. A large pouch is desirable for filling, but might not run on all available packaging equipment for ISP. The pouch size that will run on all TYJ and Fres-co equipment is a pouch size 270 mm x 380 mm. A larger pouch will reduce the number of pouches per retort batch, but due to the reduced thickness, this might be offset by faster retort cycle times. Another important factor is the size restriction for the UGR, as fold over of the pouch in the secondary packaging is not desirable.

The most capital intensive item is the retort system. It is estimated that each ISP packaging line would require 8 retorts (1400 mm style). Optimization of the retort capacity and reduction of the cycle time remain, therefore, a key recommendation in bringing the manufacturing cost of the ISP down.

The ISP is not only considered a supplemental packaging system for the polymeric tray, but also as a replacement for the #10 can. The manufacturing cost will slightly increase even though the cost for the primary packaging material decreases. Overall efficiencies in filling, sealing and retorting are lower for the #10 can, especially for products packed in brine. There are several benefits associated with the ISP as a combat ration, such as ease of preparation, less waste disposal issues and lower gross weight. These benefits are, however, difficult to quantify with traditional cost benefit calculations. The NCIC methodology, originally developed to justify capital investment by including the benefits of hard to quantify criteria, was used to evaluate the cost and benefits of the ISP versus the #10 can. Experts from the Army, Marines and Natick were used in this study. In the eyes of these experts, the ISP has an overall benefit to the soldier, even though the product will cost slightly more.

## 2 Program Management

The project was awarded on May 5, 2005 under SPO103-02-D-0024, Delivery Order 0010 with a obligation of \$46,687.00 for the phase I tasks of the proposal. Performance period for this delivery order was set at 5 months, from May 5, 2005 through October 5, 2005. The contract was awarded for the Phase I tasks to conduct a systematic analysis of the Heat and Serve (H&S) Ration System and determine the role that the Institutional Pouch (ISP) can play in meeting Surge requirements.

The following modifications were issued:

May 5, 2005	0010/01	Correction of the date of order to from April 5, 2005 to May 5, 2005
Oct 4, 2005	0010/02	No cost extension from October 4, 2005 to February 4, 2006
Feb 3, 2006	0010/03	No cost extension from February 4, 2006 to August 4, 2006
July 31, 2006	0010/04	No cost extension from August 4, 2006 to September 30, 2006

## 3 Short Term Project Activities

### 3.1 Analysis of the UGR System

There are a total of three different Unitized Group Rations (UGR's): UGR-H&S, UGR-A and UGR-B. In the following sections, each of the rations will be reviewed.

#### 3.1.1 UGR-H&S

UGR-H&S is a group ration based on fully cooked meals that only require reheating. This main entrée component is packaged in polymeric half steam table trays. This UGR-H&S ration consists of three breakfast menus and fourteen lunch/dinner menus. The breakfast menu for the Marines includes shelf stable scrambled eggs in polymeric trays, while the Army's breakfast menu uses dehydrated eggs packaged in a #10 can. The purchase breakdown of the various menu modules is approximately: 40% Breakfast Army, 5% Breakfast Marines, 55% Lunch/Dinner. The average cost of a UGR-H&S is \$285/module.

Sales UGR- H&S Menu Modules	Breakfast	Dinner	Total
2002	120,760	139,523	260,283
2003	252,332	343,443	595,775
2004	73,076	86,745	159,821
Average	148,723	189,904	338,627

Based on the outstanding solicitation "SPM300-05-R-7000", 33 different entrée items are packed in polymeric trays and thirteen entrée items are packed in #10 cans. The breakdown per menu items is listed in the attachment.

Based on the menu items listed in the new solicitation and using the average sales data during 2002-2004, the annual requirements is estimated at:

- 2,277,000 poly trays/year
- 1,038,000 # 10 cans/year

### 3.1.2 UGR-A

UGR-A is a group ration that is designed for the Army. It includes perishable items and requires some preparation before it can be served. Based on UGR-A Table I and II, revision 03/01/05, the ration consists of seven breakfast menus and fifteen dinner menus. There are eight entrée items that are packed in #10 cans. A breakdown of #10 cans per menu items can be found in the appendix. The average cost of a UGR-A is \$137/module.

Sales UGR- A Menu Modules	Breakfast	Dinner	Total
FY'02	205,070	245,970	451,040
FY'03	417,835	485,611	903,446
FY'04	378,832	494,012	872,844
Average	333,912	408,531	742,443

Based on the average sales data during FY'02 and FY'04, the estimated annual requirements for #10 cans would be 1,226,000 cans/year

### 3.1.3 UGR-B

UGR-B is a group ration designed for the Marines that contains dehydrated products and commercial type items. The UGR-B is quick and easy to prepare. It includes shelf stable ingredients to prepare complete meals. The primary package for the shelf stable entrée items and the dehydrated products is the #10 can. The ration consists of five breakfast menus and fourteen dinner menus. The average acquisition breakdown between menus is approximately: 45% Breakfast and 55% Dinner

Sales UGR- B Menu Modules	Breakfast Menu's	Dinner Menu's	Total
FY'02	8,016	9,797	17,813
FY'03	14,894	18,203	33,097
FY'04	4,574	5,591	10,165
Average	9,161	11,197	20,358

According to contract document ACR-B-01 there are 37 items packed in #10 cans. These product items can be divided into two groups: thermal processed (21 items) and non-thermal processed (16 items). The #10 cans are used in 5 breakfast and 14 dinner menus items with an average of 9.2 cans per menu item. A breakdown of #10 cans per menu items can be found in the appendix. Assuming that each menu, within breakfast group and within the dinner group, is ordered in equal quantities, 65% of the items will be thermally processed and 35% will be non-thermally processed. The average cost of a UGR-B is \$245/module.

Based on the average sales data of the period FY'02-FY'04, it is estimated that the annual requirements for #10 cans is 167,000 cans/year, a relatively small amount, compared to the requirements for the UGR-H&S and UGR-A.

### 3.1.4 Acquisition of UGR Entrees

Using acquisition data for the 2002-2004 period, the average acquisition of entrée items is estimated at 2,227,000 poly trays/year and 2,431,000 #10 cans/year. The breakdown per ration is listed in the table below.

Ration	Polymeric Tray	#10 Can
UGR-H&S	2,277,000	1,038,000
UGR-B	0	167,000
UGR-A	0	1,226,000
Total	2,277,000	2,431,000

## 3.2 Analysis of the Surge Requirements

Analysis data from DSCP (TPFDD 8/04) indicates that surge production requirements for Heat and Serve are as much as 1,650,000 trays per month or 55,000 trays/day (see tables below). It was assumed that 67% of the products are pumpable and 33% are placeable. Current polytray capacity is limited to a single producer, whose capacity is sufficient to fulfill peace time requirements but insufficient to support surge requirements. Under the most optimistic scenario, at least three production lines would be required to run at rate of 20 trays/min./line in order to meet surge requirements (assuming a 2 shift operation, 7 days/week). Actual production rates over the past years appear to be significantly less due to various reasons which are being investigated under a separate Short Term Project.

### ICIS Requirements for Modules during consecutive time frames (TPFDD 8/04)

[Modules]	0-45	46-75	76-105	106-135	136-165	166-195	196-225
UGR-H&S	184,891	233,806	221,958	201,731	248,735	210,885	154,384
UGR- A	83,710	335,632	659,526	864,308	1,005,591	1,131,529	1,186,270
UGR-B	30,249	53,434	66,438	70,727	70,727	70,727	70,727

### Estimated ICIS Poly Tray Requirements during consecutive time frames: (TPFDD 8/04)

[Poly Tray]	0-45	46-75	76-105	106-135	136-165	166-195	196-225
Placeable	361,858	457,592	434,404	394,816	486,810	412,732	302,152
Pumpable	881,458	1,114,657	1,058,172	961,741	1,185,830	1,005,383	736,017
Total	1,243,316	1,572,249	1,492,576	1,356,558	1,672,640	1,418,115	1,038,169

### Estimated ICIS #10 can requirements during consecutive time frames: (TPFDD 8/04)

[#10 Can]	0-45	46-75	76-105	106-135	136-165	166-195	196-225
UGR-H&S	1,294,237	1,636,642	1,553,706	1,412,117	1,741,145	1,476,195	1,080,688
UGR- A	251,130	1,006,896	1,978,578	2,592,924	3,016,773	3,394,587	3,558,810

UGR-B	211,743	374,038	465,066	495,089	495,089	495,089	495,089
Total	1,757,110	3,017,576	3,997,350	4,500,130	5,253,007	5,365,871	5,134,587

### **3.3 Institutional Pouch**

Because of the limited commercial demand for polymeric trays and the low volumes required during peace time, investment in polymeric tray equipment is cost prohibitive. It would be desirable to use the same packaging systems that are used for commercial production during peace time, and could be made available to support DLA's surge requirements during surge. Two packaging systems have been identified: vertical preformed pouch and horizontal form fill seal pouch. Both have been used in commercial production and could be used for surge production. The vertical pouch is most suited for pumpable products, while the horizontal form fill seal pouch is better suited for the placeable products.

The institutional vertical pouch (ISP) has, in recent years, received a lot of interest from Industry as a possible replacement for the #10 can. The available production capacity for this packaging system has dramatically increased. However, there are three draw backs that have slowed the switch between #10 cans to ISP. Not only are the filling rates slower and the final closure seal is at risk of getting contaminated, but also the issues exist in the retort process. Most vegetable products in #10 cans are packed in brine. The cans are stacked in retort baskets with simple spacer mats and often sterilized in agitating retorts to enhance the heating process. Processing these same products in ISP will require a more sophisticated racking system to support the pouch and sterilization is typically done in a non agitating retort mode, leading to lower throughput rates. Pure conductive heating type products, such as pumpkin pie, benefit from the thinner profile of the ISP. These products in ISP can be processed at higher throughput rates.

#### **3.3.1 Military Specification for ISP**

Commercial ISP packaging material utilizes either EVOH, SiO<sub>2</sub> or Aluminum as the barrier, depending on the shelf-life requirements. Pouch structures designed for commercial application are distributed at ambient temperatures and do not have to meet the requirements for frozen military distribution. Extensive research was done at the Natick Soldier System Center, evaluating various packaging materials that would survive this frozen distribution environment for the military.

On October 24, 2006, Natick issued a draft packaging specification for the Vertical Institutional Sized Pouch, describing the pouch material and the size of the pouch. See Appendix. This draft specification suggests a five layer pouch structure that is 11" wide by 16.5" long (280 mm by 420 mm). Because, the pouch needs to fit within a shipping case similar to the size used for the poly tray, it has to be folded over.

The pouch size has many implications. Limitations of packaging equipment and retort equipment need to be considered. To avoid the fold-over of the pouch in the

secondary package, the length of the pouch would need to be reduced to 320-340 mm. which might have implications for the filling operation. **In general, pouch sizing has a significant impact on the manufacturability and cost of the ISP and should be carefully researched.** This work was planned in later phases of this project but was not funded.

### 3.3.2 Analysis of the Vertical ISP Systems

According to the 2002 Allied Development Corp. report, there were four suppliers of ISP fill/seal equipment. Two of these companies were contacted: Fres-co Systems and Chori America Inc and were asked to supply equipment capability data.

#### 3.3.2.1 Fres-co

Fres-co System U.S.A. corporate office is based in Telford, Pennsylvania. They manufacture printed, laminated barrier flexible packaging material and supply leading edge packaging equipment for vacuum, gas flush, hot fill, retort and aseptic technologies. This company has developed a five layer ISP pouch that has been accepted by the Natick Soldier Systems Center to meet the military specifications.

Fres-co's main packaging equipment for ISP is the GL-90, a full automatic filler and sealer. This pouch sealer comes in three different models: GL90-GS; GL90-HF and the GL90-V.

The **GL90-GS** system is rated at 48-58 pouches/min. with four filling stations. Actual line speed is a function of product and whether a single stage or dual stage filling system is used. Systems that are setup for two stage fill of solids, followed by liquids will run at 30 pouches/min. due to the rate limitation of the solid filling system. This system uses a vacuum snorkel for headspace control.

The **GL90-HF** systems are rated at 48-58 pouches/min with four filling stations. Actual line speed is a function of product and whether a single stage or dual stage filling system is used. Systems that are setup for two stage fill of solids, followed by liquids will run at 30 pouches/min., due to the rate limitation of the solid filling system. The system uses a steam flush for headspace control.

The **GL90-V** is a vacuum system to control headspace and is rated at 20 pouches/min. Actual line speed is a function of package, product and headspace requirement.

For detailed technical information please see:  
[http://www.fresco.com/liquid\\_food\\_equipment.html](http://www.fresco.com/liquid_food_equipment.html)

The basic pouch size that can run on this equipment is:  
GL90:           Wide: 110- 600 mm, Long: 150-390 mm

### 3.3.2.2 Toyo Jidoki Co.

Toyo Jidoki Co. (TYJ) is a Japanese company with its head quarters located in Tokyo. It is considered to be an industry leader of high-quality measuring, filling and packaging systems, especially in the area of retort pouches for food packaging. In 2006, TYJ swithed from Chori America to Packaging Technologies and Inspection, LLC, 145 Main Street, Tuckahoe, NY 10707 as their main agent in the U.S.A.

TYJ has several systems that can handle Institutional Pouches. The recommended machine is a function of the pouch size, line speed, and the method of residual gas control (vacuum or steam flush).

The high end system is the **Model TT-10C2**, rated at 35 pouches/min. Actual line speed is a function of package and product. This machine has three liquid fill stations and one solid fill station, as well as a steam flush system for headspace control.

A smaller machine, but still capable of packing 3000 cc, is the **Model TT-8C2**, rated at 25 pouches/min. Actual line speed is also a function of package and product. This machine has one solid fill station and one liquid fill station, with a steam flush system for headspace control.

For those products that require a vacuum system instead of a steam flush system (cold filled products), TYJ has a **Model TVP-E5** machine that is rated at 25 pouches/min. Actual line speed is a function of package and product. This equipment uses impulse sealers in each of the vacuum chambers, compared to two heat bar sealers and a cooling bar in the previous two units.

#### Pouch Sizes:

- |           |                 |                   |
|-----------|-----------------|-------------------|
| • TT-8C2  | Wide: 150-270mm | Long: 150-400mm   |
| • TT-10C2 | Wide: 180-320mm | Long: 300-420mm   |
| • TVP-E5  | Wide: 150-290mm | Long: up to 380mm |

It should be noted that the TYJ TT-8C2 (width restriction) and TVP-E5 models (length restriction) would not be able to run the suggested pouch dimension mentioned in the Mil Spec.

### 3.3.3 Analysis of the Horizontal ISP System

Horizontal Form Fill Seal (HFFS) equipment for pouches can be obtained from a variety of vendors. Main vendors for the HFFS technology are Multivac, Convenience Food Systems and Mahaffy & Harder. Line speed of this equipment appears to be similar or better than the vertical pouch as more filling area can be made available, typically the rate limiting step. Also, the HFFS equipment is designed for placeable, cold filled products and uses vacuum for the evacuation of the pouch and heat seal plate for sealing all four seals of the pouch. The Government owns six Multivac lines that are setup for MRE pouches. The same or similar equipment can be setup to produce both MRE

pouches and Institutional Sized Pouches. The width of most of the existing GFE Multivac lines is 536 mm. a dimension that could accommodate the ISP. Industry members who use this equipment are, however, concerned about the weight of the pouch and the effect this has on the quality of the seal. **R&D will be required to assess and resolve any of these concerns and make this an acceptable dual use technology that can be used during surge.**

### 3.3.4 Analysis of the Retort System

The ISP needs to be processed in a batch retort system with over pressure control. Specific racks will be needed for this pouch if one wished to use rotational or oscillating retort mode without stressing the packaging material. Rotating and oscillating retorts increase the overall heat transfer and shorten cycle times. The leading manufacturers and/or representatives of these batch retort systems are:

- Stock America: [www.stockamerica.com](http://www.stockamerica.com)
- AllPax: [www.allpax.com](http://www.allpax.com)
- FMC [www.fmctechnologies.com](http://www.fmctechnologies.com)

The most commonly used retorts in the ration industry are 1100 mm and 1300 mm full water immersion retorts and 1400 mm spray retorts. Injection molds for polymeric trays retort racks are available that could be used for an ISP if it is sized 270 mm by 330 mm. Larger pouch sizes will require alternate retort racks as fold over of the pouch in the retort is not recommended. It should be noted that the racks designed for polymeric trays would not give adequate support to an ISP in a rotational retort process. .

Sizing of the ISP also plays a major role in optimizing the retort process. When the switch was made from metal to polymeric trays, 33% batch capacity was lost in the Stock 1100 retort. The current suggested pouch length of 280 mm by 420 mm will reduce the capacity of a 1100 retort to three pouches/layer and reduce the capacity of a 1400 size FMC spray retort to 6 pouches per layer. However, the pouch thickness is less than the height of a polymeric container, which means that more layers fit in a retort stack and some of the capacity loss can be regained with an appropriate designed rack. Also, because of the lower profile of this pouch (~29 mm), the retort cycle time is expected to be slightly less than for the polymeric tray (~45 mm) thus decreasing batch cycle time. **It is recommended that the optimal pouch size is systematically investigated to assure highest capacity at the lowest cost.**

A preliminary linear model was developed to predict retort capacity as function of pouch size. Changing the pouch dimensions has various effects. Increasing the pouch size will decrease the pouch thickness and lead to faster process times, but a larger pouch will decrease the number of pouches that can be loaded on a retort rack. On the other hand, a thinner pouch will increase the number of retort rack layers per retort batch. While this model still needs to be validated with actual data, **first impressions are that a larger pouch size could lead to increased production capacity of the retort, if retort racks are designed to take advantage of this larger but thinner retort pouch.** Also, the model also seems to indicate that lower fill weights can lead to higher retort capacity

on a per lb/hr basis. **Non validated model data** is displayed in the table below for a FMC 1400 retort. Actual capacity data will be product dependent.

Pouch Size [mm x mm]	Fill Weight [gram]	Est. Thickness [mm]	Est. Retort Load [pouch/load]	Est. Retort Capacity [lb/hr]
270 x 330	2700	54	624	1010
290 x 380	2700	32	648	1610
280 x 420	2700	29	684	1835
300 x 420	2700	26	720	2100
280 x 420	2300	24	756	2000
280 x 420	1900	19	864	2249

### 3.3.5 Analysis of the H&S Products packed in polymeric tray

Based on the information published in solicitation SPM300-05-R-7000, a total of 142,511 pumpable and 114,958 placeable products in poly trays are required on an annual basis during peace time, During surge, this quantity might increase to 1,453,974 pumpable and 823,589 placeable products in poly trays on a monthly basis, significantly higher than the TPFDD 8/04 data in section 3.2. As can be seen in the table below, not all product is required in the same quantity: White Rice, Potatoes with Cheese and Ham and Apple Dessert are the three highest volume items under pumpable. Pork Sausage Links in Brine, Turkey Sausage Links in Brine and Ham Slices in Brine are the three highest volume items under placeable. All but the Dessert items fall under the low acid canning regulations. Items such as Apple Dessert, Blueberry Dessert and Cherry Dessert fall under the acidified canning regulations and can be hot filled or pasteurized in a retort process.

#### Pumpable Products

Description	Spec	NSN		surge/month	base year	option year
Apple Dessert	<a href="#">PCR-A-003</a>	<a href="#">8940-01-455-1876</a>	1	128,195	14,210	8,686
Beef Burgundy	<a href="#">PCR-B-044</a>	<a href="#">8940-01-529-6635</a>	1	39,910	37,214	9,600
Blueberry Dessert	<a href="#">PCR-B-036</a>	<a href="#">8940-01-445-1872</a>	1	101,588	5,570	3,886
Cherry Dessert	<a href="#">PCR-C-047</a>	<a href="#">8940-01-455-1870</a>	1	37,875	20,157	4,800
Chicken and Dumplings in Gravy	<a href="#">PCR-C-051</a>	<a href="#">8940-01-503-0720</a>	1	79,819	31,460	16,464
Chicken in Szechwan style Sauce	<a href="#">PCR-C-065</a>	<a href="#">8940-01-527-5894</a>	1	13,303	27,368	2,400
Chili Macaroni, Mexican Style, w Corn and Beans	<a href="#">PCR-M-014</a>	<a href="#">8940-01-529-6844</a>	1	79,819	0	3,200
Chili with Beans	<a href="#">PCR-C-034A</a>	<a href="#">8940-01-470-3190</a>	1	39,910	0	7,200
Cream Gravy with Ground Beef	<a href="#">PCR-C-040</a>	<a href="#">8940-01-455-4609</a>	1	101,588	0	3,200
Eggs, Scrambled, Plain	<a href="#">PCR-E-005</a>	<a href="#">8940-01-470-3097</a>	1	50,707	0	4,571
Hash, Corned Beef	<a href="#">PCR-H-005</a>	<a href="#">8940-01-455-3548</a>	1	101,588	0	3,200
Macaroni and Cheese	<a href="#">PCR-M-012</a>	<a href="#">8940-01-518-9544</a>	1	39,910	28,071	7,200

Pork Sausage in Cream Gravy	<a href="#">PCR-P-014A</a>	<a href="#">8940-01-470-3204</a>	<a href="#">1</a>	101,588	0	5,486
Pork, Diced in Sweet and Sour Sauce	<a href="#">PCR-P-032</a>	<a href="#">8940-01-504-4246</a>	<a href="#">1</a>	26,606	21,266	4,800
Potatoes with Cheese and Ham	<a href="#">PCR-C-060</a>	<a href="#">8940-01-518-9217</a>	<a href="#">1</a>	152,382	0	8,229
Red Beans with Rice	<a href="#">PCR-R-009</a>	<a href="#">8940-01-519-0200</a>	<a href="#">1</a>	39,910	24,496	8,160
Rice Pilaf	<a href="#">PCR-R-004A</a>	<a href="#">8920-01-526-4909</a>	<a href="#">1</a>	39,910	36,538	7,886
Rice, White	<a href="#">PCR-R-004</a>	<a href="#">8920-01-445-5736</a>	<a href="#">1</a>	159,638	56,767	16,000
Spaghetti Pizza Bake	<a href="#">PCR-S-015</a>	<a href="#">8940-01-518-9207</a>	<a href="#">1</a>	79,819	31,026	13,200
Stuffing, Corn Bread with Sausage	<a href="#">PCR-C-056</a>	<a href="#">8920-01-517-9881</a>	<a href="#">1</a>	39,910	17,876	4,343
		<a href="#">Total</a>		1,453,974	352,019	142,511

### Placeable Products

Description	Spec	NSN		surge/month	base year	option year
Beef Taco Filling	<a href="#">PCR-T-010</a>	<a href="#">8940-01-529-6637</a>	<a href="#">2</a>	39,910	0	2,626
Chicken Breast in Gravy	<a href="#">PCR-C-032</a>	<a href="#">8940-01-445-5737</a>	<a href="#">2</a>	79,819	28,887	15,771
Chicken Breast in Lemon Pepper Sauce	<a href="#">PCR-L-004</a>	<a href="#">8940-01-517-9875</a>	<a href="#">2</a>	26,606	9,697	6,400
Chicken, Buffalo Style	<a href="#">PCR-B-039</a>	<a href="#">8940-01-517-9869</a>	<a href="#">2</a>	26,606	6,361	6,400
Ham Slices in Brine	<a href="#">PCR-H-006</a>	<a href="#">8905-01-446-0215</a>	<a href="#">2</a>	90,320	28,500	3,200
Mashed Potatoes with Chicken Gravy	<a href="#">PCR-M-010</a>	<a href="#">8940-01-504-4258</a>	<a href="#">2</a>	39,910	0	7,886
Meatballs in Brown Gravy	<a href="#">PCR-M-005</a>	<a href="#">8940-01-455-1873</a>	<a href="#">2</a>	39,910	24,412	8,160
Pasta with Ground Hot Italian Sausage	<a href="#">PCR-P-041</a>	<a href="#">8940-01-517-9823</a>	<a href="#">2</a>	79,819	33,386	15,600
Pork Ribs in BBQ Sauce	<a href="#">PCR-P-019</a>	<a href="#">8940-01-455-1882</a>	<a href="#">2</a>	39,910	12,998	7,200
Pork Sausage Links in Brine	<a href="#">PCR-P-015</a>	<a href="#">8905-01-455-3547</a>	<a href="#">2</a>	112,856	12,706	3,886
Spaghetti with Meatballs in Sauce	<a href="#">PCR-S-012</a>	<a href="#">8940-01-455-1880</a>	<a href="#">2</a>	79,819	35,718	19,200
Turkey Cutlets in Gravy	<a href="#">PCR-T-009</a>	<a href="#">8940-01-529-6641</a>	<a href="#">2</a>	66,516	36,624	13,143
Turkey Sausage Links in Brine	<a href="#">PCR-T-006</a>	<a href="#">8940-01-504-4273</a>	<a href="#">2</a>	101,588	13,953	5,486
				823,589	243,242	114,958

### 3.3.6 Analysis of the Products packed in #10 Can

The table below was supplied by DSCP. For each item, we have identified the UGR in which it is used. The products can be divided into two groups, those that need to be thermally processed (1) and those that are dry packaged (2).

It should be noted that the UGR-A uses some of the same items as UGR-B and UGR-H&S, but are identified under a different NSN: (example: Green Beans is listed under NSN 8915-00-616-4820 for UGR-H&S and UGR-B and under NSN: 8915-01-E10-0037 for UGR-A).

It should, also, be noted that a significant number of dry products are packaged in #10 cans. These products could be packed in a vacuum packed ISP, cutting down weight volume and cost. Oregon Freeze Dried is currently packaging a Chili Mac with Beef in a 6.75" by 7.5" gusseted pouch.

<b>NOMEN</b>	<b>NSN</b>	<b>Process</b>	<b>UGR-A</b>	<b>UGR-B</b>	<b>UGR-H&amp;S</b>
HAM CHUNKS #10	8905-00-023-8284	1		X	
BEEF CHUNKS #10	8905-00-926-6196	1		X	
PORK SAUSAGE LINKS #10 CN	8905-01-504-1235	1		X	
TURKEY SAUSAGE	8905-01-504-8540	1		X	
APPLESAUCE, #10 CN	8915-00-127-8272	1		X	X
PEAS #10	8915-00-127-9282	1		X	
PINEAPPLE CHUNKS #10	8915-00-170-5127	1			X
PINEAPPLE SLCD #10	8915-00-170-5148	1		X	
CORN #10	8915-00-257-3947	1		X	X
FRT COCKTAIL #10	8915-00-286-5482	1		X	X
PEACHES #10	8915-00-577-4203	1		X	X
PEARS #10	8915-00-616-0223	1		X	X
GREEN BEANS #10	8915-00-616-4820	1		X	X
CARROTS #10	8915-00-634-2436	1		X	X
MIXED VEG #10 CAN	8915-01-450-7295	1		X	X
PEAS/CARROTS #10	8915-01-487-7519	1			
BLACK BEANS #10	8915-01-516-9406	1		X	
WHITE BEANS, Great North #10	8915-01-516-9413	1		X	
Zucchini & Tomatoes	8915-01-519-1109	1			X
VEG, BEANS GREEN	8915-01-E10-0037	1	X		
BKD BEANS, IN B SUGAR & MOL (BUSH)	8915-01-E10-0038	1	X		
VEG, CORN GOLDEN WHOLE KERNEL	8915-01-E10-0060	1	X		
FRUIT, CRANBERRY SAUCE, JELLIED	8915-01-E10-0061	1	X		
VEG, PEAS EARLY OR SWEET	8915-01-E10-0082	1	X		
VEG, MIXED PEAS & CARROTS	8915-01-E10-0083	1	X		
VEG, ZUCHINNI & TOMATOS	8915-01-E10-1241	1	X		
VEG, COLLARD GREENS, CANNED	8915-01-E10-1279	1	X		
VEG, CARROTS, SLICED 3/4" TO 1 1/4" DIAM	8915-01-E10-1281	1	X		
*VEG, BEANS GREEN, ITALIAN STYLE	8915-01-E10-1433	1	x		
APPLE PIE FILLING	8940-00-616-0226	1		X	
MEATBALLS IN SAUCE #10 CN	8940-01-067-7960	1		X	
CHOCOLATE PUDDING #10 CN	8940-01-393-8412	1		X	
CREAMED SAUSAGE #10	8940-01-517-9950	1		x	
CREAMED CHIPPED BEEF	8940-01-517-9952	1		X	
PORK CHOPS, DEHYD	8905-00-935-6395	2		X	
SHRIMP #10, DEHYD	8905-01-260-7475	2		X	
DHY AMER CHEESE	8910-00-823-6880	2		X	
DHY ONION #10	8915-00-128-1179	2		X	
CHOC CKIE MIX #10	8920-00-168-3296	2		X	
SUGAR CKIE MX #10	8920-00-175-0429	2		X	

CORNBREAD MIX #10	8920-00-435-4918	2		X	
PANCAKE MIX #10	8920-00-782-6353	2		X	
YELLOW CAKE MIX	8920-00-823-7229	2		X	
BISCUIT MIX #10	8920-00-926-6016	2		X	
BROWNIE MIX #10	8920-00-935-3262	2		X	
OATML CKIE MX #10	8920-00-935-3264	2		X	
CHOC ICING MX #10	8925-00-935-3260	2		X	
CHICKEN GRAVY MIX	8940-01-368-1615	2		x	
CHILI DHY #10 / 395-4611	8940-01-395-4611	2		X	
MARGARINE #10	8945-00-222-0567	2		X	

### **3.4 ISP Capacity Requirement Analysis for Surge**

A significant quantity of #10 cans and polymeric trays are required during surge, as can be seen in section 3.2. Current production capability for polymeric trays is limited and much lower than surge requirements. As many as 1,650,000 trays need to be produced on a monthly basis or 55,000 trays/day. Assuming a production schedule of 16/hrs/day, 7 days/week and a 90% production yield, this would require a total packaging capacity of 64 trays/min. Current poly-tray production line capacity seems to be 10 trays/min. since the production base was reduced from three lines to only one line.

ISP has become an attractive alternative for the Ration program as the supplemental packaging technology for pumpable products at a higher line speed than the polymeric tray. The Demo facility has been producing for a years successfully their macaroni and cheese in ISP. We are also producing soup product for a commercial client, a second type of pumpable product.

The surge requirements for pumpable products are ~ 1,100,000 pouches/month or ~ 37,000 pouches/day. Assuming that the production schedule is 16/hrs/day, 7 days/week and a 90% production yield, a total packaging capacity of 43 pouches/min. would be required. We would need two ISP lines, running at 25 pouches/min. to keep up with the surge requirements for pumpable products and pack off 10,000 lb of product/hr.

The bottle neck in the ISP process will most likely be the retort process. Based on the information discussed before (section 3.3.4), a 1400 style retort with appropriate rack design might be able to process 3 pouches/min/retort. Each packaging line would therefore need at least 8 retorts (1400 mm style) in order to keep up with the packaging line. Less retorts would be required if faster retort cycles could be developed by using retort processes that utilize rotation or agitation. The greatest capital investment will be the retort system and any savings in retort cycle time will have significant impact on operating cost.

### 3.5 Cost Benefit Analysis of the ISP container

On August 3, 2005, an H&S PAT meeting was held at DSCP with Industry and Government to discuss the state of the ISP. The meeting was also be used as the kick off meeting for this project and to request guidance from Industry.

One of the immediate needs identified by DSCP, was a cost benefit analysis of the ISP versus #10 can, and to evaluate “difficult to quantify” criteria that differentiate both containers, using NCIC methodology. NCIC, Non Traditional Investment Criteria, was developed by Dr Boucher, professor at the Department of Industrial Engineering, Rutgers University, under the CRAMTD’s ManTech program. He used it in various CORANET projects such as a cost benefit analysis of the polymeric tray versus metal can for bakery products. Under leadership of Dr Boucher, a meeting was setup with “experts” from the Army, Marines and Natick. At this meeting, the differences between the #10 can and the ISP containers were discussed and ranked in descending order of priority.

#### Ranking of Cost Criteria of ISP versus #10 can

1.	Increase in Procurement Cost
2.	Losses Due to Improper Handling in the Field
3.	Barrier Properties for Placables

#### Ranking of Benefit Criteria of ISP versus #10 can

1.	Ease of Preparation
2.	Disposal of Waste
3.	Total Gross Weight of Module Going to Field
4.	Force Protection
5.	Reduced Injuries
6.	Food Safety

Based on this information, a questionnaire was developed, in which each expert was asked to make a pair wise comparison of the criteria. This information was then used to assign value to each criteria and a cost benefit calculation was performed as can be seen in the table below.

Criteria	Cost Difference/Container
<b>Cost:</b>	
Increase in Procurement Cost	+\$0.450
Losses due to Handling	+\$0.203
Loss of Placable Integrity	+\$0.066
Total Marginal Cost	+\$0.719
<b>Benefits:</b>	
Ease of Preparation	+\$0.418
Disposal of Waste	+\$0.298
Gross Weight going to Field	+\$0.060

Force Protection	+\$0.116
Reduced Injury	+\$0.091
Food Safety	+\$0.074
Total Marginal Benefit	+\$1.057
<b>Net: Benefit - Cost</b>	<b>+\$0.34</b>

The initial analysis was based on commercial ISP containers and did not take into account the additional cost of meeting military packaging specifications. Also, the initial study used the manufacturing cost differences, as calculated by Allied Development Corp. in 2002. At this time the manufacturing cost of ISP was estimated to be significantly higher due to lower packaging line speeds.

Since that time, the production capability for ISP has increased. DSCP has provided up dated information regarding current acquisition cost differences. Also, at the same time cost information that addressed the military specification requirements was obtained from commercial vendors. Based on this new data, the cost benefit report was updated. The conclusion of the data is that the procurement cost of the ISP has significantly decreased, offsetting almost all the cost increase necessary to meet military specifications. The net result is that the benefits of military ISP outweigh the incremental cost of the ration in an ISP.

#### Cost Benefit of a ISP based on Mil Spec

Criteria	Beef Stew	Chili with Beans	Chili w/o Beans
Cost:			
Increase in Procurement Cost	+\$0.550	-\$1.840	+\$0.610
Losses due to Handling	+\$0.203	+\$0.203	+\$0.203
Loss of Placable Integrity	+\$0.066	+\$0.066	+\$0.066
Total Marginal Cost	+\$0.819	-\$1.571	+\$0.879
Benefits:			
Ease of Preparation	+\$0.418	+\$0.418	+\$0.418
Disposal of Waste	+\$0.298	+\$0.298	+\$0.298
Gross Weight going to Field	+\$0.060	+\$0.060	+\$0.060
Force Protection	+\$0.116	+\$0.116	+\$0.116
Reduced Injury	+\$0.091	+\$0.091	+\$0.091
Food Safety	+\$0.074	+\$0.074	+\$0.074
Total Marginal Benefit	+\$1.057	+\$1.057	+\$1.057
Benefit – Cost per ISP	+\$0.238	+\$2.628	+\$0.178

For more detailed information about this analysis see TWP# 223 in the appendix

The recommendations of the cost-benefit analysis were:

- Manufacturability study should be executed to develop an economic model for the production system to validate the manufacturing cost, as well as developing strategies to decrease the manufacturing and packaging cost.
- The five layer pouch and the secondary packaging adds significant costs to the ISP. Also, the secondary packaging material significantly increases the weight and waste volume of the ISP. **A cost benefit analysis of the five layer pouch and the cardboard sleeve should be made and all alternative options should be considered.**
- A significant number of non-thermal stabilized products are packed in #10 cans. Replacement of these products with ISP would not require the same heavy duty five layer packaging material as required for the thermally stabilized products. A separate evaluation should be done to study the cost impact of ISP, using the appropriate pouch material, for these types of products. In addition, consideration should be given as to which items can be vacuum packed to yield volume reduction in the meal module.

### **3.6 Next Steps:**

The two industry members that participated at the project kick-off meeting responded to our request to prioritize CORANET R&D focus areas. The suggested list of potential R&D areas was that was given to the attendees is listed below. They were encouraged to add to this list.

Suggested R&D Areas:

- Pouch Sizing
- Secondary packaging
- Retort rack Design
- Retort Processing: (Rotation/Oscillation)
- Performance Specification
- Quality Assurance testing
- Online Seal Inspection
- Residual Gas Control
- Horizontal Form Fill Seal

Producer A priority list was:

- Pouch Sizing
- Four sided burst test, or non destructive testing
- Secondary Packaging
- Performance Specifications

Producer B priority list was:

- Retorting using Rotation or Oscillation
- Pouch Sizing
- Seal Inspection.

Both Companies identified Pouch Sizing as a high priority items. There are several issues that need to be considered in pouch sizing:

- Available packaging equipment for ISP
- Available retort equipment and rack design
- Fill weight specifications
- Finished product specification
- Assembled ration specifications
- Packaging Material Cost

## **4 Appendix:**

- **UGR Menu Breakdown**
- **TWP#223: Cost Benefit Analysis Institutional Pouch**
- **Specification Packaging of Food in Flexible Pouches 24 Oct 05**

## **UGR Menu Breakdown**

[illegible]

[illegible]

[illegible]

CORANET RATIONS NETWORK FOR TECHNOLOGY IMPLEMENTATION  
(CORANET)

Technical Working Paper #223

**Cost Benefit Analysis Institutional Pouch**

TO  
Defense Logistics Agency  
United States Department of Defense

Contract: SPO103-02-D-0024

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8/28/06

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### **1. Objective:**

Analyze the Cost and Benefits associated with the replacement of #10 Cans in an UGR-B Meal Module by Institutional Sized Pouches (ISP)

### **2. Methodology:**

Replacement of a container such as the #10 Can by an Institutional Sized Pouch can result with many incremental costs and cost savings that occur over the entire life cycle of the product. Areas such as manufacturing, acquisition, transportation, and field use of the product are being affected. The impact in certain areas such as the impact on manufacturing cost can be calculated based on traditional cost analysis. The impact in field use is however more subjective and harder to quantify. To assess the costs/benefits of a new container system to the end user, it requires that criteria that differentiate one container versus the others are identified and perceived costs or benefits are assigned to each of them. The net value assigned to the benefits and costs criteria determines if the benefits of the new container outweighs the incremental cost associated with the change over.

### **3. NCIC**

The methodology to evaluate difficult to quantify cost-benefit criteria was developed under the DLA ManTech Program “CRAMTD” by Dr T. Boucher, professor in the Industrial & Systems Engineering Department at Rutgers University. This methodology, “Non Traditional Capital Investment Criteria” or “NCIC”, has been used several times to justify capital investment decisions in advanced technology when there are important difficult-to-quantify criteria included in the investment justification. NCIC allows us to assign monetary value to such criteria by pair wise comparisons among criteria and assigning relative importance to these criteria. This same methodology is used in this case study in order to assign value to hard to quantify costs and benefits.

#### **3.1 NCIC Philosophy**

Whenever the costs and benefits can be directly computed from objective data, it should be done in the traditional cost-benefit fashion. However, it is well-established in industry that many decisions are hard to justify on known economic benefits alone. Managers refer to the “intangible” factors as difficult-to-quantify but very important. For example, the decision to invest in a technology that will improve product quality will result in measurable gains, for example, lower cost from lower reject rates. Engineers can often be fairly precise about the magnitude of these cost savings. On the other hand, improved product quality has a second order effect that is not so easily measured. That comes from the improved acceptance of the product by customers, which may allow the company to charge a higher price or obtain an improved market share. Since the customers’ reaction is speculative, it is difficult to put a dollar value on this factor. NCIC was developed to deal with this kind of issue.

NCIC assumes that there exists an economic rational for difficult-to-quantify factors but it is not easy to make a computation directly. NCIC initially relies on the expert

opinion of those who know the decision environment the best. By eliciting their judgment in a formal way, NCIC computes an economic value that is “implied” from the responses of the experts. These economic values (costs and benefits) are then available to be integrated into the overall economic analysis.

Before accepting any particular implied value, it is often desirable to test it in a “post audit” of the NCIC analysis. Specifically, the underlying assumptions that could justify the implied value should be discussed and determined to be reasonable. Consider, for example, the case of quality improvement previously mentioned. Since the sources of difficult-to-quantify value can be price improvement or market share gain, it is possible to compute the ranges of these variables that would be consistent with the implied value. Then the only question left to the experts and their management committee is “Do those assumptions seem reasonable?” If they do, management has a range of future expectations that can be monitored after the investment is made. It will be seen later that this same principle can be applied to making a decision about the ISP package.

NCIC provides a way to back into economic estimates using the judgment of experts, which can then lead to further discussion and agreement or disagreement about the assumptions under which those estimates seem reasonable. It provides a formal procedure for arriving at values implied by experts that can be tested against reasonable assumptions.

### **3.2 Phases in the NCIC Process**

There are three major phases in NCIC: 1) Determining and ranking the criteria, 2) Comparing the importance of criteria against each other using pair wise judgmental comparisons, 3) Computing the average of the importance weights and their implied dollar values. This can be followed by a post audit examination of underlying assumptions that give rise to value, a phase that we have applied in previous studies.

The first phase of the current study took place on October 17, 2005. Domain experts from Natick, Marines, and ACES met with NCIC facilitators at Rutgers and a list of cost and benefit criteria were established. The criteria on these lists were then rank ordered by the group. The facilitators noted at the time that the participants encountered some difficulty in quickly agreeing on the ranking of minor benefit criteria.

### **3.3 The Method of Comparing Criteria**

In the second phase of the NCIC process, experts were asked to compare the relative importance of each criterion to other criteria. The scale to measure relative importance is 1 to 9, where 1 means that the two criteria being compared are equally important. If a criterion is dominated by a factor greater than 9, it is considered trivial and probably adds little value in the overall analysis. It might even be dropped from the analysis.

Comparisons can be made in a group session or by individuals. A group session requires that the group reach agreement on a numerical value for each comparison. This

is quite time consuming and a persuasive personality in the group may bias the independent judgment of individuals. Individual votes can be assimilated into a group judgment by taking the average response of the group for each comparison. Since this approach limits interaction among the experts, it excludes any clarification that would occur in group discussion. Due to the time involved and the difficulty of scheduling, in the current study judgments were rendered individually and averaged in order to obtain the group norm.

### 3.4 The Method of Computing Weights and Implied Dollar Values

The third phase of the analysis is the computation of criteria weights and implied monetary values. The computational method used by NCIC is well-known in the field of decision theory. There is no mystery about it. The computational method assumes that people are not always consistent when comparing the importance of things and that averaging judgments over a number of related comparisons yields the best indicator of how a respondent values each thing.

Consider the hypothetical pair wise comparison matrix of criteria A, B, and C shown below. The respondent is asked to rate each row criterion against each column criterion. The diagonal values of “1” are assumed and the respondent makes entries above the diagonal. The below diagonal entries are simply the reciprocal values of the above diagonal entries. From the above diagonal entries it can be seen that A is judged to be 3 times more important than B and A is judged to be 9 times more important than C. In the second row the decision maker judges B to be 3 times as important as C. This makes perfect sense. If A is 3 times B and 9 times C, then the importance of B to C must be  $\frac{9}{3} = 3$ . We say that the decision maker is perfectly consistent, which is rare.

	A	B	C
A	1	3	9
B	1/3	1	3
C	1/9	1/3	1

For this data set it is very easy to compute a set of weights indicating the relative importance of each criterion using any column of the matrix since the matrix is “perfectly consistent”. NCIC normalizes the weights so that they equal “1”. The computation is shown in the following table using the first column of the matrix.

Criterion	Matrix Values	Normalized Weights
A	1	$1 \div 1\frac{4}{9} = 0.692$
B	1/3	$\frac{1}{3} \div 1\frac{4}{9} = 0.231$
C	1/9	$\frac{1}{9} \div 1\frac{4}{9} = 0.077$
	Sum= $1\frac{4}{9}$	<b>Total= 1.000</b>

Unfortunately, individuals are not always so consistent when making comparison among things. It is important to use *all the data* provided by the individual in order to arrive at the best estimate of how they judge the importance of each factor. Consider the comparison matrix below. Note that the decision maker has an opinion about the relative importance of B to C that is at some odds with direct comparisons with A. A direct calculation of normalized weights, as shown above, cannot be done.

	A	B	C
A	1	3	9
B	1/3	1	2
C	1/9	1/2	1

NCIC's computational method does a kind of weighted averaging of all the comparisons to arrive at the weights that best represent how the decision maker feels about criterion A, B and C overall. The weights that would result from this set of judgments is as follows.

Criterion	Normalized Weights
A	0.703
B	0.207
C	0.090
	<b>1.000</b>

An intuitive explanation for the reduction in the relative importance of B from the prior computation is that the reduction in the relative importance of B when compared to C in the matrix of comparisons has lowered the relative value of B. Both A and C have gained from the relative reduction in the importance of B.

Finally, this brings us to the source of "Implied Values." If criterion A is a measured annual benefit of \$10,000 determined using a traditional financial analysis, then the

relative value of B implied by its weight is easily computed as  $\$B = 10,000 \frac{0.207}{0.703} = \$2945$ .

### 3.5 Summary

The NCIC approach provides a process for getting at the value of the difficult-to-quantify criteria in a decision. It helps clarify a decision scenario by first getting experts together to specify, list and rank what the important difficult-to-quantify criteria are. Then it gives them a framework for using their judgment to evaluate the relative importance of criteria and automatically generates a set of weights and implied economic values to include these criteria in the overall analysis. Finally, the decision makers can follow up on the values generated for difficult-to-quantify criteria by making explicit the underlying assumptions that would make those values true. The reasonableness or unreasonableness of these assumptions should be the basis of further discussion aimed at accepting or revising the analysis. We will emphasize this last point when discussing the results of the current evaluation of the ISP package.

### 4. Model System

There are three Unitized Group rations that use of the #10 Can in their meal modules: UGR-A, UGR-B and UGR-H&S. Of these three meal modules, UGR-B contains the highest number of #10 Cans per module and the impact of the container replacement by ISP would be most significant in this ration. The average number of #10 Cans in this UGR-B meal module is 9 containers of which 6 are thermal stabilized and 3 non thermal stabilized products. Therefore, the UGR-B was used as the model system for this evaluation and analysis, containing 9 containers. For cost comparison it was assumed that no significant difference in the cost-benefit criteria exist between the two thermal and none thermal stabilized products.

### 5. Acquisition Cost

In a separate study, sponsored by the Natick Soldiers Systems Command, Allied Development Corporation performed a manufacturing cost analysis of the ISP vs. #10 can. The report performed two case studies, one for “Whole Kernel Corn” and one for “Sliced Peaches”. The case study for Whole Kernel Corn estimated that the manufacturing and acquisition cost of the Institutional Pouch would be around 18% higher than the current cost of Whole kernel Corn purchased in a #10 can. The main reason for this incremental cost was the anticipated 50% reduction in manufacturing throughput rate for the Institutional Pouch and thus a higher impact of fixed cost.

Currently the average DSCP acquisition cost for Fruits and Vegetables in #10 can is around \$2.50 (Corn: \$2.71, Peaches: \$2.74, Beans: \$2.13). An 18% increase in cost would therefore equate to about \$0.45/can. This \$0.45 cost differential was used in the NCIC analysis as a reference point to which other cost-benefit criteria were compared

It should be noted that the increase in manufacturing cost was based on thermal stabilized items. It is anticipated that the incremental cost for non thermal stabilized items might be lower or even result in a cost decrease as cheaper pouch material can be used, possible elimination of secondary packaging requirements and the manufacturing throughput rate might be less effected. For this case study it was assumed that the acquisition cost of the non-retorted items would also increase with \$0.45/container.

## 6. Cost Benefit Criteria

To establish the cost/benefit criteria associated with the change over to a new container system, representatives of both Army and Marines as well as representatives of the Natick Combat Ration Feeding program were invited to a meeting. The objective was to establish criteria that differentiate the container systems from each other. After establishing the criteria that differentiate the two containers, the representatives were asked to rank each of the criteria in order of relative importance. The results of these discussions can be seen in Tables 1 & 2

Table 1. Ranking of Cost Criteria

1.	Increase in Procurement Cost
2.	Losses Due to Improper Handling in the Field
3.	Barrier Properties for Placables

Table 2. Ranking of Benefit Criteria

1.	Ease of Preparation
2.	Disposal of Waste
3.	Total Gross Weight of Module Going to Field
4.	Force Protection
5.	Reduced Injuries
6.	Food Safety

## 7. Detailed explanation of the Cost and Benefit Criteria

In the following section, we will briefly discuss each of the criteria in more detail

### 7.1. Costs:

1. **Increase in Procurement Cost** – Assume that there are nine #10 Cans replaced by nine ISP and that each ISP will cost \$0.45 more than its #10 counter part. Using current acquisition cost information, it is estimated that the procurement cost, by the services, of a UGR-B meal module that feeds 50 soldiers will increase from \$245 to about \$249.05, an increase of \$4.05 ( $9 \times 0.45$ ) or a 1.7% increase.
2. **Losses due to Improper Handling in the Field** – The ISP is more prone to punctures. A puncture renders an ISP useless and it will be discarded. No actual product loss data is available, but is assumed that the performance of the ISP should be similar to the MRE

3. **Barrier Properties for Placables** – The potential for breakage of some placable items exists with the ISP due to the flexibility of the packaging material. Although breakage does not render the food uneatable, it reduces the esthetic quality of the meal.

## 7.2. Benefits:

1. **Ease of Preparation** – The food containers of a meal module need to be heated in water before they can be opened. The existing baseline for heating food in the #10 Can is 45 minutes. Special grippers are required to remove the #10 can from the hot water bath and the can needs to be opened with care as it is pressurized by the heating step. The ISP reduces the time it takes to prepare the meal prior to feeding. Time savings come not only from the fact that the ISP heats up more quickly due to each smaller profile, but also more ISP container can fit in a hot water bath. Furthermore, the ISP is easier to extract from a hot bath, and opens more easily with a knife or scissors.
2. **Disposal of Waste** – It is assumed that the volume of waste for 9 emptied #10 cans will be reduced from 2396 inch<sup>3</sup> to 968 inch<sup>3</sup> for nine ISP's and their secondary packaging sleeve. The packaging materials are typically returned from the forward combat zone to a secure area for disposal. The secondary packaging material can be burned and the ISP will be disposed by burial in a burn pit. Benefits of ISP come from a reduction in the physical volume required for disposal and the associated site preparation effort required.
3. **Total Gross Weight of Module going to Field** – One ISP, including secondary packaging material, will weigh 0.3 lbs less than its #10 counter part. Assuming that the meal module (three boxes) weighs approximately 130 lbs and the ISP based meal module weighs 2.7 lb less, a 2% weight reduction of an ISP meal module compared to a #10 Cans meal module.
4. **Force Protection** – The emptied #10 Can, if acquired by insurgents, has potential for usage as a container for improvised explosive devices. The ISP is deemed less likely to be used for this purpose.
5. **Reduced Injuries** – The ISP, having no sharp edges and not requiring the use of a can opener, is less likely to cause cuts or other minor injuries during use.
6. **Food Safety** – The ISP packaging material is inert and not prone to corrosion during long time storage.

## 8. Case Study Results

In the second phase of the NCIC process, a questionnaire (see appendix) was sent to representatives of the Army and Marines as well as Natick. They were asked to quantify the relative importance of each criterion to each other in a pair wise comparison. The average response for each pairs wise comparison was then entered into the NCIC software.(see table below for the average values of all experts). The NCIC software evaluated the responses and calculate the value of each cost/benefit criteria. .

MATERIAL CONVERSION							
	A	B	C				
A - ANNUAL DOLLARS	1	3.6	4.2				
B - HANDLING LOSS	0.27778	1	5				
C - BARRIER PROTECTION	0.2381	0.2	1				
Consistency Ratio: 0.20688							
INFORMATION CONVERSION							
	A	B	C	D	E	F	G
A - ANNUAL DOLLARS	1	2	3.3	5	2.3	3	3.8
B - EASE OF PREP	0.5	1	3.3	5.7	3.5	4.7	4.3
C - WASTE DISPOSAL	0.30303	0.30303	1	5	4.2	4.7	6
D - GROSS WEIGHT	0.2	0.17544	0.2	1	0.5	0.5	0.5
E - FORCE PROTECTION	0.43478	0.28571	0.2381	2	1	0.7	0.6
F - REDUCED INJURY	0.33333	0.21277	0.21277	2	1.42857	1	1
G - FOOD SAFETY	0.26316	0.23256	0.16667	2	1.66667	1	1
Consistency Ratio: 0.07448							

The final results of this analysis can be seen in the table below. These results measure the marginal cost and benefits of the ISP over the #10 can.

#### **Summary Responses by Branch and Overall: (Dollars)**

Criteria	Natick	Marines	ACES	Overall*
Cost:				
Increase in Procurement Cost	4.05	4.05	4.05	+\$4.05
Losses due to Handling	1.30	1.39	3.08	+\$1.83
Loss of Placable Integrity	0.38	0.47	1.04	+\$0.59
Total Marginal Cost	5.73	5.91	8.17	+\$6.47
Benefits:				
Ease of Preparation	2.52	2.96	5.51	+\$3.76
Disposal of Waste	2.03	2.54	3.64	+\$2.68
Gross Weight going to Field	0.37	0.54	0.94	+\$0.54
Force Protection	1.34	1.48	0.94	+\$1.04
Reduced Injury	2.30	0.59	0.70	+\$0.82
Food Safety	0.63	0.71	0.77	+\$0.67
Total Marginal Benefit	9.19	8.82	12.50	+\$9.51
Benefit - Cost	3.46	2.91	4.33	+\$3.04

\*: The overall cost/benefit of each criterion is based on averaging the responses of the experts to each question in the questionnaire. It is not the average or weighted average of each branch criterion.

The net benefit of replacing the #10 can by ISP is valued at \$3.04 per average UGR-B module, or \$0.34/ISP.

Criteria	Module	Container
Cost:		
Increase in Procurement Cost	+\$4.05	+\$0.450
Losses due to Handling	+\$1.83	+\$0.203
Loss of Placable Integrity	+\$0.59	+\$0.066
Total Marginal Cost	+\$6.47	+\$0.719
Benefits:		
Ease of Preparation	+\$3.76	+\$0.418
Disposal of Waste	+\$2.68	+\$0.298
Gross Weight going to Field	+\$0.54	+\$0.060
Force Protection	+\$1.04	+\$0.116
Reduced Injury	+\$0.82	+\$0.091
Food Safety	+\$0.67	+\$0.074
Total Marginal Benefit	+\$9.51	+\$1.057
Benefit - Cost	+\$3.04	+\$0.34

## 9. Post Analysis Audit

We will now discuss each of the criteria and perform a reality check.

### 9.1. Cost Criteria

The introduction of the ISP container has three major drawbacks. Increased procurement cost, increased losses due to handling and increased loss of product integrity. The experts estimated that the total incremental cost for the ISP would equate to \$6.47 per meal module or \$0.719/container.

#### 9.1.1. Increase in Procurement Cost

The increase in manufacturing cost was analyzed by Allied Development Corporation. They performed two case studies, one for “Whole Kernel Corn” and one for “Sliced Peaches”. The case study for Whole Kernel Corn estimated that the manufacturing and acquisition cost of the Institutional Pouch would be around 18% higher than the current cost of Whole Kernel Corn purchased in a #10 can. The main reason for this incremental cost was the anticipated 50% reduction in manufacturing throughput rate for the Institutional Pouch and thus a higher impact of fixed cost. Based on this study, it was calculated that the acquisition cost of the ISP would be about \$0.45

higher than the #10 can, which would increase the cost of our model UGR-B with  $9 \times 0.45 = \$4.05$ , assuming that there would no cost difference in the assembly process for UGR-B. We should however recognize that the Allied study was done several years ago (2002) and that ISP technology has made progress which might have had a significant impact on the manufacturing cost. We recommend that a new manufacturing cost model is developed, using today's manufacturing assumptions. This model can also assist in identifying areas of opportunity to lower that manufacturing and packaging cost.

### 9.1.2. Losses due to Handling

Besides the increased manufacturing cost, it is also anticipated that the container is less durable during rough handling, which might lead to loss of product. The cost assigned by the experts was \$1.85 per meal module or \$0.206/container. Depending of the value of the ration, one could calculate the implied defect ratio that the expert assumed.

The value of the ISP in the fields could be significantly higher than just the acquisition cost of the ISP. Added value of assembly, storage, shipment, distribution, etc should be considered into the value of each component of the Meal Module. The table below calculates the implied defect rate as function of the ISP value. It is based on the implied cost of \$0.206/container assigned by the experts due to losses of the product:

Value ISP	Calculated Defect Rate
\$3.20	6.4%
\$5.00	4.1%
\$7.50	2.7%
\$10.00	2.1%
\$15.00	1.4%

Example calculation:

- 1) Assume the value of an ISP is \$3.20
- 2) NCIC implied added cost to the meal module for product loss due to improper handling is \$1.85 or  $\$0.206/\text{ISP}$  ( $= \$1.85/9$ )
- 3) If we assume that the loss is limited to value of the ISP, we can calculate the assumed defect rate of ISP at 6.4% ( $= 0.206/3.20$ )

It is our observation from the data that the expert judgments on the cost criteria were less consistent than we would normally anticipate. This inconsistency is in part caused by the expert opinion on product losses due to handling. It is also our personal believe that the loss of product will be significantly less than the above table would make you believe. This could mean that the experts have over estimated the significance of the occurrence of product loss, or the expert assigned a much higher value to the loss of a container than the true value of the container. An argument could be made that replacing a container that is being lost due to mishandling might not be as easy replaced in the

battle field than for a regular consumer whom would go to the pantry to get a different container.

It is expected that the typically loss of product should be more like one in thousand (0.10%) or less, which would significantly reduce the incremental cost of the ISP due to product losses, as can be seen in the table below. It is our recommendation that this cost component be reassessed by the expert panel. We recommend that they try to reach consensus on an estimate of the expected defect rate and the value of the ISP is to their consumer in the battle field.

Value of ISP	Assumed Defect Rate		
	1.00%	0.10%	0.01%
\$3.20	\$0.032	\$0.003	\$0.000
\$5.00	\$0.050	\$0.005	\$0.001
\$7.50	\$0.075	\$0.008	\$0.001
\$10.00	\$0.100	\$0.010	\$0.001
\$15.00	\$0.150	\$0.015	\$0.002

Incremental cost ISP due to product loss

Note: Incremental cost for an ISP due to product loss should be multiplied by the number of containers in a Meal Module to assign value to the cost criterion at a Meal Module basis

### **9.1.3. Loss of Placeable Integrity**

The ISP is a flexible container and provides less protection to the food inside the container. Some of the more fragile products, such as pork sausages, might have a degree of broken items if packed in a flexible container. The perceived cost of this criterion was valued at \$0.59/meal module or \$0.066/container. It is hard to validate this criterion via traditional analysis, but it implies that the consumer is willing to spend for every container an extra \$0.066 to avoid loss of product integrity in those products that might be sensitive to breakage.

## **9.2. Benefit Criteria**

The ISP container has six benefit criteria. The perceived benefits assigned to these criteria were valued at \$9.51 per meal module or \$1.057/container. We will review each of these criteria.

### **9.2.1. Ease of Preparation**

The most important benefit criterion for ISP is the ease of preparation, which was valued at \$3.76/meal module or \$0.418/container. This benefit criterion was defined as the labor cost savings associated with heating, opening and serving the product. At an assumed labor rate of \$17/hr (benefits included), this would mean about 88 seconds labor

savings per container, which appears to be a reasonable estimate.  $(=\$0.418 [\text{\$}] * 3600 [\text{sec/hr}] / 17 [\text{\$/hr}])$

### **9.2.2. Disposal of Waste**

The second most important benefit criterion is the reduction in waste volume that needs to be transported back to a disposal site and buried. The waste volume of a #10 can is 266.2 inch<sup>3</sup>, while the volume of an empty ISP container is 9.3 inch<sup>3</sup> and its protective cardboard sleeve is 98.2 inch<sup>3</sup>. For a 9 container meal module, this means a reduction in waste disposal of  $9*(266.2-9.3-98.2)= 1428 \text{ inch}^3$ , or 0.83 ft<sup>3</sup>. The #10 can and the pouch need to be buried, the cardboard sleeve can be burned if the tactical situation allows this.

The experts assigned an implied value of \$2.68 per meal module to the lower waste volume of an ISP based module, or \$0.298 per ISP container. As with the ease of preparation, this criterion is defined a labor savings criteria and using the same labor rate (\$17/hr), this would mean about a 63 seconds labor savings per container which seems to be reasonable estimate.  $(=\$0.298 [\text{\$}] * 3600 [\text{sec/hr}] / 17 [\text{\$/hr}])$

This benefit in a combat situation appears, however, to be an order of magnitude higher than the savings that can be calculated for commercial waste disposal within the United States. The disposal cost of one cubic yard (27 ft<sup>3</sup>) at the CAFT Demo facility is estimated at \$9, or \$0.33/ft<sup>3</sup>. The savings in waste volume, using domestic commercial waste disposal system would therefore result only in \$0.28 savings per meal module or \$0.03/ISP container. The large discrepancy between cost savings for waste disposal in a combat zone versus domestic commercial disposal might be attributable to the efficiency of commercial waste disposal systems which is highly mechanized that requires minimal manual labor.

### **9.2.3. Gross Weight going to Field**

A #10 can weighs about 0.7 lbs, while a pouch weighs about 0.1 lbs and the cardboard sleeve weighs about 0.3 lbs, resulting in a net weight reduction of 0.3 lb per ISP or 2.7 lbs/meal module. Assuming a meal module gross weight of 130 lbs (divided over 3 boxes), it is estimated that an ISP based meal module will result in a 2% weight reduction.

Based on the NCIC approach, the end user assigned an implied value of \$0.54/meal module or about \$0.060/ISP container. The criterion of gross weight reduction was valued as least important, while the criterion in the initial discussion was rated at the number three level. It appears that the experts had difficulty assigning value to this criterion, maybe partially due to the fact that they are not directly responsible for the transportation cost. Therefore, it is recommended that this criterion is also evaluated with a more traditional analysis of transportation cost savings.

It should be noted that the reduction in weight of an ISP based meal module was greatly offset by the weight of the required secondary packaging material, needed to

protect the ISP. An analysis on the minimum required secondary packaging material should be performed and the impact on increased transportation cost should be balanced against the increased risk of pouch damage during transportation.

#### **9.2.4. Force Protection, Injury and Food Safety**

The third, fourth and fifth benefit criteria (reduction in injury, increase food safety and force protection) were each valued at respectively \$1.04, \$0.82 and \$0.67 for a total valued benefit of \$2.53/module or \$0.281/container. These are truly NCIC type criteria and very difficult to quantify via traditional methods.

### **10. Impact of Military Specifications**

The Manufacturing cost comparison performed by Allied Development Corporation estimated a cost increase of the ISP by around 18%. Based on DSCP acquisition data for fruits and vegetables in #10 cans, it was estimated that the incremental cost would be around \$0.45/container. What is lacking in the Allied Study was the impact of the military packaging requirements. At that time it was assumed that a four ply structure (OPET/foil/OPET/OPP) would be adequate for these products. Subsequently, extensive work at Natick has resulted in the requirements for a five layer structure (OPET/nylon/foil/nylon/OPET/OPP) that can withstand both hot and cold weather distribution. Based on quotes from a pouch suppliers, it is estimated that the military specification for the pouch will increase the cost of the ISP with an additional \$0.19/ISP over the cost of a commercial four ply ISP.

In addition the military secondary packaging requirements were not considered by Allied Development Corporation. They made an assumption that 12 ISP's would be packed in a case, which would make for a ~78 lbs case, too heavy for normal handling. Typically six #10 cans are packed in a case (~39 lbs), a more realistic assumption for commercial ISP's as well. Allied Development Corp did assume that the cost for shipping materials would be equivalent to the cost for shipping materials for a #10 can, which seems to be a reasonable assumption for 6 ISP's/case. It is our understanding that, that six ISP's are packed in a case with divider sheets in between each pouch for a typical commercial application.

Mil Spec's require that each pouch is packed inside a cardboard sleeve and that only four pouches are packed in a case. This will increase the cost for packaging material for ISP. We obtained quotes for the secondary packaging cost from one of our local vendor. They estimated the cost for commercial ISP secondary packaging, including divider sheets between each pouch, at \$1.58/case or \$0.263/container. They estimated the cost for mil spec secondary packaging (case + four sleeves + liner) at \$2.41/case or \$0.603/container. Therefore, the impact of the military secondary specification will add an additional \$0.34/container.

Considering both primary and secondary packaging cost, the mil spec ISP will add an additional \$0.53 (\$0.19 + \$0.34) over the commercial version of the ISP. This incremental cost in packaging material needs to be added to the cost difference in

manufacturing cost between the commercial ISP and #10 can, using the manufacturing cost estimate developed by Allied Industry. This would increase the acquisition cost of the container with \$0.98 (=\$0.45 + \$0.53), or \$8.82 for a UGR containing 9 ISP's. Using the NCIC analysis results, this cost increase would now exceed the benefits of an ISP based meal module that meets current Mil Spec, as can be seen in the table below.

Comparison of a Meal Module

Criteria	Commercial	Mil Spec
Cost:		
Increase in Procurement Cost	+\$4.05	+\$8.82
Losses due to Handling	+\$1.83	+\$1.83
Loss of Placable Integrity	+\$0.59	+\$0.59
Total Marginal Cost	+\$6.47	+\$11.24
Benefits:		
Ease of Preparation	+\$3.76	+\$3.76
Disposal of Waste	+\$2.68	+\$2.68
Gross Weight going to Field	+\$0.54	+\$0.54
Force Protection	+\$1.04	+\$1.04
Reduced Injury	+\$0.82	+\$0.82
Food Safety	+\$0.67	+\$0.67
Total Marginal Benefit	+\$9.51	+\$9.51
Benefit – Cost per Meal Module	+\$3.04	-\$1.73
Or Benefit – Cost per ISP (/9)	+\$0.34	-\$0.19

## 11. Current Pricing

Subsequent to this analysis, DSCP solicited actual cost data from its vendors for comparable product packaged in #10 cans and in commercial ISP (both containers are sized for ~6.5 lb of product). As can be seen in the table below, Beef Stew and Chili w/o Beans are slightly more expensive and Chili with Beans significant cheaper than the #10 can. **It should be questioned if the quality of these products in both containers is similar**

	#10 Can	ISP	Difference
Beef Stew	\$7.65	\$7.67	+\$0.02
Chili with Beans	\$9.71	\$7.34	-\$2.37
Chili w/o Beans	\$9.36	\$9.44	+\$0.08

But will the commercial ISP withstand the distribution system of the Government? Packing the above items in Mil Spec compliant primary and secondary packaging material could increase the cost by \$0.53/ISP (see chapter 10)

	#10 Can	Commercial ISP	Mil Spec ISP (+\$0.53)	Difference
Beef Stew	\$7.65	\$7.67	\$8.20	+\$0.55
Chili with Beans	\$9.71	\$7.34	\$7.87	-\$1.84
Chili w/o Beans	\$9.36	\$9.44	\$9.97	+\$0.61

Based on this data, only Chili with Beans would result into a tradition cost savings, the other two products will lead to a significant cost increase. However, if we consider the implied value that was calculated using NCIC methodology, all three products packed in ISP would deliver a net benefit to the customer, as can be seen in the table below.

#### Cost Benefit of a ISP based on Mil Spec

Criteria	Beef Stew	Chili with Beans	Chili w/o Beans
Cost:			
Increase in Procurement Cost for commercial ISP	+\$0.020	-\$2.370	+\$0.080
“Upgrade” to Mil Spec	+\$0.530	+\$0.530	+\$0.530
Losses due to Handling	+\$0.203	+\$0.203	+\$0.203
Loss of Placable Integrity	+\$0.066	+\$0.066	+\$0.066
Total Marginal Cost	+\$0.819	-\$1.571	+\$0.879
Benefits:			
Ease of Preparation	+\$0.418	+\$0.418	+\$0.418
Disposal of Waste	+\$0.298	+\$0.298	+\$0.298
Gross Weight going to Field	+\$0.060	+\$0.060	+\$0.060
Force Protection	+\$0.116	+\$0.116	+\$0.116
Reduced Injury	+\$0.091	+\$0.091	+\$0.091
Food Safety	+\$0.074	+\$0.074	+\$0.074
Total Marginal Benefit	+\$1.057	+\$1.057	+\$1.057
Benefit – Cost per ISP	+\$0.238	+\$2.628	+\$0.178

## 12. Conclusion

The NCIC methodology allows one to evaluate, and document the value of various difficult to quantify cost benefit criteria via an interview process of the experts. The methodology calculates a monetary value to each of the criteria, which can then audited to see if the estimates are reasonable.

Identifying and assigning value to hard to quantify criteria that differentiate two products is done by all of us. Most of the time, we do not do this following a systematic approach nor do we document the results for later validation. For example, one who buys a new car will consider traditional criteria such as acquisition cost and annual operation cost. But we also consider hard to quantify criteria such as safety features, convenience

features, consumer report info, dealer reputation etc. In our subconscious, we assign value to these criteria and come to a decision which car will suits our needs. Seldom will we document the value that we assigned to these hard to quantify criteria. NCIC gives us this ability.

The NCIC methodology was used to evaluate the cost-benefit criteria that differentiate the ISP from the #10 can in the UGR-B ration. As experts, we interviewed end user representatives from the Army and the Marines, as well as a representative from Natick. Overall, the end user reps assigned more value to the benefits associated with this ISP packaging system than to the incremental cost of the ISP container, which would justify the ISP introduction. The main cost component was the increased acquisition cost (as calculated by Allied Development Corp), while the main benefit to the end user was the ease of product preparation. Overall, the end user reps assigned a net savings of \$0.34/ISP.

The incremental acquisition cost of the ISP in the Allied Development Corp report resulted mainly from a 50% reduction in manufacturing throughput rates. The study was several years old (2002) and progress has been made to overcome some of the manufacturing hurdles. Also, the Allied Development Corp, assumed a four layer ISP pouch with commercial secondary packaging. Both had a significant impact on the acquisition cost of the ISP. DSCP obtained quotes for three similar products that are produced in both #10 can and ISP. The quotes were based on commercial packed product. Backing out the Allied Development Corp estimated acquisition cost and replacing it with the acquisition cost obtained by DSCP and upgrading the packaging material to Mil Spec compliancy, we developed a revised cost benefit table (Chapter 11: Current Pricing).

Using the current acquisition pricing and the implied cost-benefit values, as calculated by NCIC, for difficult to quantify criteria, both Beef Stew and Chili w/o Beans in ISP yields a small benefit to the user. Packaging Chili with Beans in ISP yields a significant savings to the Government. (Note: It is not quite clear why there is such a difference between the two Chili products and one might want to investigate if the qualities of these products are comparable)

### **13. Recommendations**

It is recommended that the economic manufacturability model for ISP is updated to reflect today's assumptions. This economic model can then be used to develop strategies to decrease the manufacturing and packaging cost. For example, one might want to investigate what the effect of retort cycle time has on the total manufacturing cost, and use this information to justify R&D activities in this area.

It was noted that the five layer pouch and the secondary packaging adds significant cost to the ISP beyond the manufacturing cost as identified by the Allied study. It was also noted that the secondary packaging material significantly offsets the weight and

waste volume benefits of the ISP. Therefore, we recommend a cost benefit analysis of the five layer pouch and the cardboard sleeve versus the commercial ISP versus some alternative packaging system.

During the evaluation of the UGR-B, it was observed that a significant number of non-thermal stabilized products are packed in #10 cans. Replacement of these products with ISP would not require the same heavy duty five layer packaging material as required for the thermal stabilized products. It is recommended that a separate evaluation be done to study the cost impact to convert these items to ISP, using an appropriate pouch material. In addition, it should be evaluated which of these items can be vacuum packed to yield volume reduction in the meal module, a criteria that was not identified as a significant evaluation criterion in the current study.

The post analysis audit of the values assigned to criteria has led to two recommendations to further improve the study. The first recommendation is to review with the experts their assumptions concerning the ISP defect rate and conduct a distribution test to establish actual defect rate in the field. The second recommendation is to evaluate transportation cost reductions using a more traditional cost analysis by DSCP transportation specialists in order to estimate the impact of gross weight reductions, using typical military distribution scenarios from the assembly point to the battle field.

## Appendix:

### Instruction for Completing the Questionnaire

The questionnaire asks the respondent to compare the criteria of section 2 **in pairs**. The form of a typical question is as follows:

“When substituting an ISP (UGR-B) module for an equivalent #10 Can module, how much more important is **Criterion A** to **Criterion B**? (Scale 1-9) Ans. \_\_\_\_\_”

Note the following about the question:

1. It uses the *UGR-B module* as a basis on which to think about the comparison.
2. It requires an answer on a scale of 1 to 9. There is a body of research in psychometrics that indicates that this is probably the best scale for humans making such pair wise comparisons.
3. The questions will be asked such that a criterion that is more highly ranked (Criterion A) will be compared to one that is of lower rank (Criterion B). See Tables 1 & 2 for ranking. Therefore, the appropriate answers will be at least 1 (A & B are about of equal importance) and at most 9 (A is much much more important than B).
4. If the respondent believes that, for a particular comparison, Criterion B is trivial when compared to A, just enter “>9” (greater than 9).
5. Fractional answers are acceptable, for example,  $2\frac{1}{2}$ , 4.75, etc.
6. If a comparison between A and B is responded to with a value, say “3” (A is 3 times more important than B), then a comparison between A and C, when C is ranked lower than B in Table 1 or 2, should receive a response of 3 or greater. This is consistent with the ordering of Tables 1 and 2.

For some questions it is possible for the questioners to provide further guidance to the respondent. If this is the case a “guideline” section will immediately follow the question for clarification. The guideline should help the respondent to consider some of the assumptions behind his/her response.

## **Questionnaire**

### **Comparison of Cost Criteria:**

1. When substituting an ISP (UGR-B) module for a #10 Can module, how much more important is the procurement cost increase of \$4.05 (1.7%) to the potential losses due to improper handling in the field (punctures, etc.)? (Scale 1-9) Ans. \_\_\_\_\_

**Guideline:** Since it is known that a puncture in a pouch renders the ISP contents useless, it is possible to roughly compute the dollar value of a single punctured pouch using its purchase price. Then the answer to the above question actually depends on the respondents' assumption about the actual puncture rate per 1000 pouches shipped to the field. Using available cost information, the table below is an approximate estimate of the appropriate response based on the assumed puncture rate (assuming that the economic loss is limited to the acquisition cost of the ISP).

<b>Assumed Defect Puncture Rate</b>	<b>Correct Response (1-9)</b>
1/1000 (0.1%)	>9
5/1000 (0.5%)	>9
10/1000 (1.0%)	>9
16/1000 (1.6%)	9
20/1000 (2.0%)	7
30/1000 (3.0%)	4.7
40/1000 (4.0%)	3.5
50/1000 (5.0%)	2.8

2. When substituting an ISP (UGR-B) module for a #10 Can module, how much more important is the procurement cost increase of about \$4.05 (1.7%) to the potential breakage of placables due to lower barrier protection? (Scale 1-9) Ans. \_\_\_\_\_

**Guideline:** The numerical answer must be greater than or equal to the answer to question 1.

3. When substituting an ISP (UGR-B) module for a #10 Can module, how much more important are the potential losses due to improper handling in the field (punctures) to the potential breakage of placables due to lower barrier protection? Scale (1-9) Ans. \_\_\_\_\_

#### **Comparison of Benefit Criteria:**

4. When substituting an ISP (UGR-B) module for a #10 Can module, how much more important is the procurement cost increase of \$4.05 (1.7%) to the ease of meal preparation using the ISP? (Scale 1-9) Ans. \_\_\_\_\_

**Guideline:** Ease of preparation, at a minimum, results in reduced preparation time. There are nine containers in the UGR-B module. The answer to this question will depend on the assumed time savings and the assumed value of the Marine's or Soldier's time. If, for example, one were to assume that the skill value was equivalent to that of an average U.S. production worker (hourly wage of about \$17), the following table would indicate the value of various levels of time savings.

Time Saved	2 min	5 min	10 min	14 min	20 min
Cost Saved	\$0.52	\$1.42	\$2.83	\$3.97	\$5.67
Scale (1-9)	7.1	2.9	1.4	1.0	0.7*

\* We have assumed that no individual benefit criterion is larger than the procurement cost increase. If this were not true, the analysis would be unnecessary.

5. When substituting an ISP (UGR-B) module for a #10 Can module, how much more important is the procurement cost increase of \$4.05 (1.7%) to the reduction in the disposal of waste using the ISP module? (Scale 1-9) Ans. \_\_\_\_\_

**Guideline:** For nine #10 Cans replaced by ISP, the volume of waste is reduced from 2396 cu in to 968 cu in (volume of the ISP = 84 cu in, volume of the secondary packaging sleeve = 884 cu in).

6. When substituting an ISP (UGR-B) module for a #10 Can module, how much more important is the procurement cost increase of \$4.05 (1.7%) to the reduction of total gross weight of the module going to the field? (Scale 1-9) Ans. \_\_\_\_\_

**Guideline:** The substitution of ISP for #10 Cans reduces the weight of a module by 2%.

7. When substituting an ISP (UGR-B) module for a #10 Can module, how much more important is the procurement cost increase of \$4.05 (1.7%) to improving force protection by eliminating the #10 Can for possible reuse in IED manufacture? (Scale 1-9) Ans. \_\_\_\_\_

8. When substituting an ISP (UGR-B) module for a #10 Can module, how much more important is the procurement cost increase of \$4.05 (1.7%) to the potential reduction in minor injuries due to cuts, etc.? (Scale 1-9) Ans. \_\_\_\_\_

9. When substituting an ISP (UGR-B) module for a #10 Can module, how much more important is the procurement cost increase of \$4.05 (1.7%) to the potential improvement in food safety? (Scale 1-9) Ans. \_\_\_\_\_

10. When substituting an ISP (UGR-B) module for a #10 Can module, how much more important is the ease of preparation to the reduction in disposal of waste? (Scale 1-9) Ans. \_\_\_\_\_

11. When substituting an ISP (UGR-B) module for a #10 Can module, how much more important is the ease of preparation to the reduction of total gross weight of the module going to the field? (Scale 1-9) Ans. \_\_\_\_\_

12. When substituting an ISP (UGR-B) module for a #10 Can module, how much more important is the ease of preparation to improving force protection by eliminating the #10 Can for possible reuse in IED manufacture? (Scale 1-9) Ans. \_\_\_\_\_

13. When substituting an ISP (UGR-B) module for a #10 Can module, how much more important is the ease of preparation to the potential reduction in minor injuries due to cuts, etc.? (Scale 1-9) Ans. \_\_\_\_\_

14. When substituting an ISP (UGR-B) module for a #10 Can module, how much more important is the ease of preparation to the potential improvement in food safety? (Scale 1-9) Ans. \_\_\_\_\_

15. When substituting an ISP (UGR-B) module for a #10 Can module, how much more important is the reduction in waste materials to the reduction of total gross weight of the module going to the field? (Scale 1-9) Ans. \_\_\_\_\_

16. When substituting an ISP (UGR-B) module for a #10 Can module, how much more important is the reduction in waste materials to improving force protection by eliminating the #10 Can for possible reuse in IED manufacture? (Scale 1-9) Ans. \_\_\_\_\_

17. When substituting an ISP (UGR-B) module for a #10 Can module, how much more important is the reduction in waste materials to the potential reduction in minor injuries due to cuts, etc.? (Scale 1-9) Ans. \_\_\_\_\_

18. When substituting an ISP (UGR-B) module for a #10 Can module, how much more important is the reduction in waste materials to the potential improvement in food safety? (Scale 1-9) Ans. \_\_\_\_\_

# **Specification Packaging of Food in Flexible Pouches 24 Oct 05**

INCH-POUND

MIL-PRF-44073F  
4 September 2001  
SUPERSEDING  
MIL-PRF-44073E  
9 February 1996

W/ Change 02 24 OCT 05

## PERFORMANCE SPECIFICATION

### PACKAGING OF FOOD IN FLEXIBLE POUCHES

This specification is approved for use by all Departments and Agencies of the Department of Defense.

#### 1. SCOPE

1.1 Scope. This specification covers the performance criteria for packaging materials and the packaging of food in flexible pouches to include the filling and hermetic sealing of the pouches, the thermal processing of the filled and sealed pouches for commercial sterility, and the unit packing of the pouches into cartons.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, U.S. Army Soldier and Biological Chemical Command, Natick Soldier Center, ATTN: AMSSB-RCF-F(N), Natick, MA 01760-5018 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC 89GP

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

1.2 Classification. Packaging and thermal processing of product shall be of the following types and classes, as specified (see 6.1).

1.2.1 Types. The packaging types are as follows:

Type I - Single Serving Pouch (SSP)

Type II - Institutional Size Pouch (ISP)

1.2.2 Classes. The classes are as follows:

Class 1 - For meat, poultry, and fish with sauce and gravy

Class 2 - For vegetables with sauces

Class 3 - For fish, meat and poultry in loaf, slice, or solid form

Class 4 - For fruit

## 2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in section 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in section 4 of this specification, whether or not they are listed.

~~2.2 Government documents. None.~~

2.2 Government documents, drawings and publications.

2.2.1 Specifications, standards and handbooks. None.

2.2.2 Other government documents. The following other Government documents drawings and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

### U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES

Federal Food, Drug and Cosmetic Act and regulations (21 Code of Federal Regulations (CFR), Parts 170-189)

(Copies of this document are available from [www.access.gpo.gov/nara](http://www.access.gpo.gov/nara) or Superintendent of Documents, ATTN: New Orders, P.O. Box 371954, Pittsburgh, PA 15250-7954.)

2.3 Non-Government publications. The following documents form a part of this document to the

extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.1).

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

### D 999-01 – Methods for Vibration Testing of Shipping Containers

### D1974-98 (2003) – Standard Practice for Methods of Closing, Sealing, and Reinforcing Fiberboard Boxes

D 3985-02e1 05 - Oxygen Gas Transmission Rate Through Plastic Film and Sheeting Using a Coulometric Sensor

### D 5118/D 5118M-05 – Standard Practice for Fabrication of Fiberboard Shipping Boxes

### D 5276-98(2004) – Test Method for Drop Test of Loaded Containers by Free Fall

F 372-99 (2003) - Standard Test Method for Water Vapor Transmission of Flexible Barrier Materials Using an Infrared Detection Technique

(Application for copies should be addressed to the ASTM-International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

## 3. REQUIREMENTS

### 3.1 Performance characteristics.

#### 3.1.1 Pouch material.

3.1.1.1 Fabrication. The pouch material shall be capable of being fabricated into pouches as specified in 3.1.2. The material used for the pouch shall be safe for use with food by reference to, and in accordance with 21 CFR, Part 170-189, applicable material safety datasheets, or other recognized health standards and regulations.

3.1.1.2 Oxygen transmission rate. The oxygen transmission rate ( $O_2TR$ ) of the material shall not exceed  $0.06 \text{ cc/m}^2/24 \text{ hrs/atm}$ .

3.1.1.3 Water vapor transmission rate. The water vapor transmission Rate (WVTR) of the material shall not exceed  $0.01 \text{ gm/m}^2/24 \text{ hrs}$ .

3.1.1.4 Thermal processing. The material when fabricated into pouches shall be capable of withstanding the thermal process specified in 3.1.5. If the material used is a multi-layered laminate, it shall show no evidence of delamination after thermal processing when examined in accordance with 4.2.

3.1.1.5 Environmental conditions.

3.1.1.5.1 Low temperature (Type I). After thermal processing, the filled and sealed Single Serve Pouch (SSP) pouch shall withstand pouch abuse at 28°F with a survival rate of 75 percent when tested in accordance with 4.3.4.1.

3.1.1.5.2 High temperature (Type I). After thermal processing, the filled and sealed SSP pouch shall withstand pouch abuse at 160°F with a survival rate of 100 percent when tested in accordance with 4.3.4.2.

3.1.1.5.3 Standard temperature (Type II). After thermal processing, the filled and sealed Institutional Size pouch (ISP) shall withstand pouch abuse at 72°F with a survival rate of 100 percent when tested in accordance with 4.3.4.3.

3.1.1.5.4 Frozen temperature (Type II). After thermal processing, the filled and sealed ISP shall withstand pouch abuse at -20°F with a survival rate of 75 percent when tested in accordance with 4.3.4.4.

3.1.1.6 Camouflage. The color of outside surfaces of the SSP pouch, ~~before and~~ after thermal processing, shall contribute to field camouflage. For ISP, commercial pouches are acceptable.

3.1.2 Pouch configurations and dimensions. Pouch configurations and dimensions for 5 and 8 ounce SSP pouches shall be as specified in figure 1 (see 6.1). Pouch configuration and dimensions for the ISP shall be as specified in figure 3 (see 6.1).

3.1.3 Pouch filling.

3.1.3.1 Eight ounce pouch. Products requiring an average net weight of 8 ounces or less but more than 5 ounces shall be filled into an 8 ounce size pouch. Placeable products may be filled into an 8 ounce pouch.

3.1.3.2 Five ounce pouch. Products requiring an average net weight of 5 ounces or less shall be filled into a 5 ounce size pouch.

3.1.3.3 Institutional size pouch. Products requiring an average net weight ranging from 48 to 104 ounces shall be filled into an ISP.

3.1.4 Pouch sealing.

3.1.4.1 Residual gas. Residual gas volume in the filled and sealed SSP pouches shall not

exceed 10 cubic centimeters (cc) in pouches packed with Class 4 products, nor shall the residual gas volume exceed 20 cc in SSP pouches packed with Class 1, Class 2, or Class 3 products, when tested in accordance with 4.3.6. Residual gas volume in the filled and sealed ISPs shall not exceed 250 cc when tested in accordance with 4.3.6.

3.1.4.2 Closure seal. The closure seal width shall be a minimum 1/8 inch. The closure seal shall be free of impression or design on the seal surface that would conceal or impair visual detection of seal defects. The closure seal shall be free of wrinkles, occluded matter, or evidence of entrapped moisture or grease that reduces the closure seal width to less than 1/16 inch at any location along its continuous path when examined in accordance with 4.2.

3.1.4.3 Internal pressure. The pouches shall be filled and hermetically sealed such that after thermal processing, the pouches shall withstand 20 psig for 30 seconds when tested in accordance with 4.3.7.

3.1.5 Thermal processing. Filled and sealed pouches shall be thermally processed as specified in the applicable food product document.

3.1.5.1 Commercial sterility. Thermally processed pouches shall be free of swelling or microbial activity when tested in accordance with 4.3.8.

3.1.5.2 Pouch defects. Filled and sealed thermally processed pouches shall be free of damage (tears, cuts, holes, or if a multi-layer laminate is used, abrasions through one or more layers in the pouch material, or leakage through any heat seal) when examined in accordance with 4.2.

### 3.1.6 Carton design.

3.1.6.1 Carton design for 8 ounce size pouches (Type I). The SSP carton, when closed and sealed, shall completely enclose the pouch to prevent physical damage and entry of foreign matter when examined in accordance with 4.2.1.

3.1.6.2 Carton design for 5 ounce size pouches (Type I). The SSP carton, when closed and sealed, shall completely enclose pouch to prevent physical damage and entry of foreign matter when examined in accordance with 4.2.1.

3.1.6.3 Carton color. The color of all inside and outside SSP and ISP carton surfaces shall be natural kraft, tan or dull gray.

3.1.6.4 Carton dimensions (Type I). The inside length and width dimensions of the SSP carton shall be equal to the outside length and width dimensions of the pouch. The carton depth shall be 5/8 inch ( $\pm$  1/16 inch).

3.1.6.5 Carton design (Type II). The ISP carton, when closed and sealed, shall enclose pouch to prevent physical damage when examined in accordance with 4.2.1.

3.1.6.6 Carton dimensions (Type II). The outside length, width and height of the ISP carton

shall not exceed 12-13/16 x 10-3/4 x 2-1/8 inches.

3.1.7 Unit packing of pouches in cartons.

3.1.7.1 Pouch in carton (Type I). Each SSP carton shall contain one flat, fully extended pouch.

3.1.7.2 Carton closure (Type I). Each SSP carton shall be securely closed. The closure shall have a bond strength greater than the fiber tear of the paperboard when examined in accordance with 4.3.9.

3.1.7.3 Pouch in carton (Type II). Each ISP carton shall contain one pouch. One end of ISP may be folded to accommodate fitting the pouch into the carton.

3.1.7.4 Carton closure (Type II). The top and bottom faces of the carton shall be compressed and the ends taped.

3.1.7.5 Carton label (Type II). A label with the following instructions shall be printed, stamped, or otherwise applied onto the carton, in a manner that does not damage the carton, with permanent ink of any contrasting color. Type size of the label shall be no smaller than shown below (printed on 8-1/2" x 11" paper), but can be larger.

**ATTENTION!**

**PROTECTIVE CARTON-DO NOT THROW AWAY**

**SAVE AND RE-USE TO PROTECT  
POUCH FROM DAMAGE**

**To Avoid Damaging Pouch:**

**1. Keep Pouch in Carton Until Ready to Heat, Then Remove.**

**2. Insert Pouch Back Into Carton After Heating.**

**3. Always Use Cartons When Transporting  
Pouches in Insulated Food Containers.**

**4. If Cartons Are Unavailable, Stack Pouches  
With Fiberboard Pads in Between.**

**In addition, the product name shall be correctly and legibly labeled on the carton.**

**4. VERIFICATION**

4.1 Conformance inspection. Conformance inspection shall include the examinations of 4.2 and 4.2.1, and the tests of 4.1.1, and 4.3.1 through 4.3.9.

4.1.1 Pouch material testing. The pouch material shall be tested for the performance characteristics listed in table I.

TABLE I. Pouch material tests

Characteristic <u>1/</u>	Requirement paragraph	Test method
Oxygen transmission rate	3.1.1.2	4.3.1
Water vapor transmission rate	3.1.1.3	4.3.2
Thermal processing	3.1.1.4	4.3.3
Low temperature (Type I)	3.1.1.5.1	4.3.4.1
High temperature (Type I)	3.1.1.5.2	4.3.4.2
Standard temperature (Type II)	3.1.1.5.3	4.3.4.3
Frozen temperature (Type II)	3.1.1.5.4	4.3.4.4
Camouflage (Type I)	3.1.1.6	4.3.5
Residual gas	3.1.4.1	4.3.6
Internal pressure	3.1.4.3	4.3.7

1/ In lieu of testing, determination of compliance to O<sub>2</sub>TR, WVTR, environmental conditions, and camouflage requirements may be ascertained by examination of records, invoices, or other valid documents. In addition, compliance to the requirements for outside pouch dimensions and dimensions of manufacturer's seals may be verified by certificate of conformance.

4.2 Examination of pouch. After thermal processing, the pouches shall be visually examined for compliance with the requirements specified in 3.1.1, 3.1.2, 3.1.3, 3.1.4, and 3.1.5. Defects and defect classifications are listed in table II.

TABLE II. Filled, sealed and thermal processed pouch defects

Category				Defect
<u>Critical</u>	<u>Major A</u>	<u>Major B</u>	<u>Minor</u>	

1		Swollen pouch.
2		Tear, cut, hole, or if a multi-layered laminate is used, abrasion through one or more layers in the pouch material or leakage through any heat seal.
3		Foldover wrinkle extending into the seal such that the closure seal is reduced to less than 1/16 inch.
4		Presence of entrapped matter (for example, product, moisture, grease, etc.) that reduces the closure seal to less than 1/16 inch.
5		Presence of delamination when a multi-layered laminate is used. <u>1/</u>
	101	Unclean pouch. <u>2/</u>
	102	Any impression or design on the heat seal surfaces which conceals or impairs visual detection of seal defects. <u>3/</u>
	103	Less than 3/16 inch between inside edge of tear notch and inside edge of seal.
	104	Closure seal not located as specified.
	105	Pouch labeling is missing <b>or</b> incorrect or illegible.
	151	Presence of delamination when a multi-layered laminate is used. <u>1/</u>
	152	Closure seal width not as specified.
	201	Presence of delamination when a multi-layered laminate is used. <u>1/</u>
	202	Tear notches missing or not as specified.

TABLE II. Filled, sealed and thermal processed pouch defects (cont'd)

Category				Defect
<u>Critical</u>	<u>Major A</u>	<u>Major B</u>	<u>Minor</u>	

- |     |   |
|-----|---|
| 203 | Tear notches not located as specified.                |
| 204 | Depth of tear notches not as specified.               |
| 205 | Color of SSP does not contribute to field camouflage. |
- 

1/ Delamination defect classification:

Critical - Evidence of outer ply delamination such that the adjacent ply in the pouch body is exposed or evidence of two ply delamination such that the food contactant layer is exposed.

Major B - Delamination of the outer ply in the pouch seal area that can be propagated to expose the adjacent ply at the food product edge of the pouch after manual flexing of the delaminated area. To flex, the delaminated area shall be held between the thumb and forefinger of each hand with both thumbs and forefingers touching each other. The delaminated area shall then be rapidly flexed 10 times by rotating both hands in alternating clockwise-counter clockwise directions. Care shall be exercised when flexing delaminated areas near the tear notches to avoid tearing the pouch material. After flexing, the separated outer ply shall be grasped between thumb and forefinger and gently lifted toward the food product edge of the seal or if the separated area is too small to be held between thumb and forefinger, a number two stylus shall be inserted into the delaminated area and a gentle lifting force applied against the outer ply. If separation of the outer ply can be made to extend to the product edge of the seal with no discernible resistance to the gentle lifting, the delamination shall be scored as a Major B defect. Additionally, spot delamination of the outer ply in the body of the pouch that is able to be propagated beyond its initial borders is also a Major B defect. To determine if the delaminated area is a defect, use the following procedure: Mark the outside edges of the delaminated area using a bold permanent marking open. Open the pouch and remove the contents. Cut the pouch transversely not closer than 1/4 inch (plus or minus 1/16 inch) from the delaminated area. The pouch shall be flexed in the area in question using the procedure described above. Any propagation of the delaminated area, as evidenced by the delaminated area exceeding the limits of the outlined borders, shall be scored as a Major B defect.

Minor - Minor delamination of the outer ply in the pouch seal area is acceptable and shall not be classified as a minor defect unless it extends to within 1/16 inch of the food product edge of the seal. All other minor outer ply delamination in the pouch seal area or isolated spots of delamination in the body of the pouch that do not propagate when flexed as described above shall be classified as minor.

2/ Scale or dust on the outside of pouches caused by retort water may be removed by washing. The following examples shall not be scored as defects for unclean:

- a. Water spots.
- b. On SSP, two or less specks of dried product each of which measure 1/8 inch by 1/8 inch or equivalent area, or less. On ISP, ten or less specks of dried product each of which measure

1/8 inch by 1/8 inch or equivalent area, or less.

c. Any foreign matter which presents no health hazard or no potential pouch damage and which readily falls off when pouch is lifted and shaken lightly.

d. Very thin film of grease, oil, or product residue which is discernible to touch, but not readily discernible by visual examinations.

e. Thin strips or drops of adhesive.

3/ If doubt exists as to whether or not the sealing equipment leaves an impression or design on the heat seal surfaces that could conceal or impair visual detection of seal defects, samples shall be furnished to the contracting officer for a determination as to acceptability.

4.2.1 Examination of pouch and carton assembly. The pouch and carton assembly shall be examined for compliance with the requirements specified in 3.1.6 and 3.1.7. Defects and defect classifications are listed in table III.

TABLE III. Pouch and carton assembly defects

Category			Defect
<u>Critical</u>	<u>Major</u>	<u>Minor</u>	
1			Tear, hole, or puncture through carton or open carton causing a hole in the pouch or obviously wet or stained carton due to leaking pouch.
	101		Tear or hole in carton exposing pouch to potential damage.
	102		Outer flaps of carton not closed.
	103		Carton not clean.
	104		Type I pouch body not in a flat, fully extended position in SSP carton.

TABLE III. Pouch and carton assembly defects (cont'd)

Category			Defect
<u>Critical</u>	<u>Major</u>	<u>Minor</u>	
	105		Carton labeling is missing, incorrect or illegible.

106		Bond strength in SSP carton closure is not greater than fiber strength of paperboard of carton.
107		Type II pouch does not fit into the ISP carton. 1/
	201	Tear or hole in carton not exposing pouch to potential damage.
	202	Color of carton not as specified.
	203	Outer flaps of SSP carton not closed to within 1/2 inch of either end.
	204	The ISP carton not closed as specified.

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1/ Pouches with a folded end shall not be scored as a defect.

#### 4.3 Tests.

4.3.1 Oxygen transmission rate. The oxygen transmission rate of the material shall be determined in accordance with ASTM D 3985, at 73°F and 50 % RH.

4.3.2 Water vapor transmission rate. The water vapor transmission rate of the material shall be determined in accordance with ASTM F 372, at 100°F and 90 % RH.

4.3.3 Thermal processing. Testing for thermal processing of the material shall be as follows: Material shall be formed into ~~5 or 8 ounce size pouches~~ SSP or ISP in accordance with figure 1 or 3, as applicable. Pouches shall be filled with five or eight, or 48 ounces of water, as applicable, sealed and exposed to the same thermal processing conditions as required for filled and sealed pouches by the food product document. Following thermal processing, pouches shall be examined visually. Any pouch material defect as a result of thermal processing shall be considered a test failure.

#### 4.3.4 Environmental conditions.

4.3.4.1 Low temperature (Type I). Fill the SSP pouches with water, seal and thermal process as in 3.1.5. After thermal processing, unit pack in paperboard cartons. Condition the unit packs in an atmosphere uniformly maintained at 28°F ± 2°F for a period of 48 hours. During exposure, position the unit packs to allow free circulation of air around each pack. Conduct a pouch abuse test while still in the frozen state using the test apparatus shown in figure 2. For eight ounce unit packs, the drop height shall be 40 inches; for five ounce unit packs, the drop height shall be 64 inches. Drop each unit pack twice, once on each end. Recondition tested unit packs to ambient

temperature for at least 24 hours, remove pouches from cartons and examine visually. Any pouch leakage shall be considered a test failure.

4.3.4.2 High temperature (Type I). Fill the SSP pouches with water, seal and thermal process as in 3.1.5. After thermal processing, unit pack in paperboard cartons. Condition the unit packs in an atmosphere uniformly maintained at  $160^{\circ}\text{F} \pm 2^{\circ}\text{F}$  for a period of 48 hours. During exposure, position the unit packs to allow free circulation of air around each pack. Conduct a pouch abuse test using the test apparatus shown in figure 2. For eight ounce unit packs, the drop height shall be 40 inches; for five ounce unit packs, the drop height shall be 64 inches. Drop each unit pack twice, once on each end. Recondition tested unit packs to ambient temperature for at least 24 hours, remove pouches from cartons and examine visually. Any pouch leakage shall be considered a test failure.

4.3.4.3 Standard temperature (Type II). Each pouch, filled with either water or a representative food product, processed as specified in the applicable food document shall be inserted into the carton as specified in 3.1.7. Four filled, sealed and thermal processed ISP pouches shall be packed in a fiberboard box conforming to style RSC-L, type CF, grade 275 of ASTM D 5118. The box shall be closed in accordance with ASTM D 1974. Condition the box of four ISPs in an atmosphere uniformly maintained at  $72^{\circ}\text{F} \pm 2^{\circ}\text{F}$  for a period of 48 hours. Conduct a drop test in accordance with ASTM D 5276, Ten Drop Cycle at a height of 21 inches. Immediately after completion of the drop test, conduct a vibration test (on the same box of four ISPs) in accordance with ASTM D 999, at 268 RPM (4.5 Hz) for a period of one hour. Remove ISPs from the box and examine visually. Any cracked, split or leaking ISP at any location, or tear, hole, or puncture through the carton causing a hole in the ISP; or wet or stained carton due to one or more leaking ISPs; or any evidence of food product leakage from ISP shall be considered a test failure.

4.3.4.4 Frozen temperature (Type II). Prepare the box of four ISPs as specified in 4.3.4.3, but condition in an atmosphere uniformly maintained at  $-20^{\circ}\text{F} \pm 2^{\circ}\text{F}$  for a period of 48 hours. While still in frozen state, conduct drop and vibration tests as specified in 4.3.4.3. Remove ISPs from the box and allow to fully thaw prior to visual examination. Any cracked, split or leaking ISP at any location, or tear, hole, or puncture through the carton causing a hole in the ISP; or wet or stained carton due to one or more leaking ISPs; or any evidence of food product leakage from ISP shall be considered a test failure.

4.3.5 Camouflage (Type I). External visible color of the outside surfaces of the SSP pouch material ~~before and~~ after thermal processing shall conform to the range of the government approved and standardized color swatches. Standardized swatch samples have been provided to and are on file with each contractor, each material supplier, USDA, Natick, and DSCP. Visibly match the outside surface of the pouch material to the range of colors of the standardized color swatch samples.

4.3.6 Residual gas volume test. The samples for test shall be opened under  $75^{\circ}\text{F} \pm 5^{\circ}\text{F}$  water and the gases shall be collected by water displacement in a graduated cylinder or other calibrated tube. The volume of the gases shall be reported to the nearest 0.1 cubic centimeter (cc) for SSP.

Any residual gas volume exceeding 20 cc in SSP pouches filled with Class 1, Class 2, or Class 3 products shall be considered a test failure. Any residual gas volume exceeding 10 cc in SSP pouches filled with Class 4 products shall be considered a test failure. The volume of the gases shall be reported to the nearest 1 cc for ISP. Any residual gas volume exceeding 250 cc in ISP pouches shall be considered a test failure.

4.3.7 Internal pressure test. Internal pressure resistance shall be determined by pressurizing the pouches while they are restrained between two rigid plates. The plates shall be spaced 1/2 inch  $\pm$  1/16 inch apart for SSP and 2 inches  $\pm$  1/16 inch for ISP. If a three-seal tester (one that pressurizes the pouch through an open end) is used, the closure seal shall be cut off for testing the side and bottom seals of the pouch; for testing of the closure seal, the bottom seal shall be cut off. The pouches shall be emptied prior to testing. If a four-seal tester (designed to pressurize filled pouches by use of a hypodermic needle through the pouch wall) is used, all four seals can be tested simultaneously. Pressure shall be applied ~~at the approximate uniform rate of 1 psig per second~~ gradually until 20 psig pressure is reached. The 20 psig pressure shall be held constant for 30 seconds and then released. The pouches shall then be examined for separation or yield of the heat seals. Any rupture of the pouch or evidence of seal separation greater than 1/16 inch in the pouch manufacturer's seal shall be considered a test failure. Any seal separation that reduces the effective closure seal width to less than 1/16 inch (see table II) shall be considered a test failure.

4.3.8 Commercial sterility test. Incubate filled, sealed and thermally processed pouches as follows:

- a. Classes 1, 2, and 3: Incubate at  $95^{\circ}\text{F} \pm 5^{\circ}\text{F}$  for 10 days, unless otherwise specified by the inspection agency.
- b. Class 4: Incubate at  $80^{\circ}\text{F} \pm 5^{\circ}\text{F}$  for 10 days.

Any evidence of swelling or microbial activity following incubation shall be considered a test failure.

4.3.9 Carton closure bond strength. Compliance with required bond strength in carton closure shall be verified by visually examining flaps for evidence of fiber tear after opening. Absence of fiber tear shall be considered a test failure.

## 5. PACKAGING

This section is not applicable to this specification.

## 6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of the specification.
- b. **Type and** class required (see 1.2).
- c. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.3).
- d. Pouch sizes for ~~class 1, 2, 3, and 4~~ **SSP** (see 3.1.2 and figure 1).
- e. **Pouch size for ISP** (see 3.1.2 and figure 3).

## **6.2 Pouch material.**

**6.2.1 Type I pouch material.** The U.S. Army Soldier Biological and Chemical Command (SBCCOM), Natick Soldier Center (NSC) has found that for preformed **SSP** pouches, a material structure consisting of, from inside to outside, 0.003 to 0.004 inch thick polyolefin, 0.00035 to 0.0007 inch thick aluminum foil, 0.0006 inch thick biaxially oriented polyamide-type 6, and 0.0005 inch thick polyester meets the performance criteria of this specification. Alternatively, the aluminum foil layer and the biaxially oriented polyamide layer may be in either order. For the formed, tray-shaped body of a horizontal form-fill-seal (HFFS) **SSP** pouch, it has been found that a material structure consisting of, from inside to outside, 0.003 to 0.004 inch thick polyolefin, 0.0006 inch thick biaxially oriented polyamide-type 6, 0.0015 to 0.00175 inch thick aluminum foil and 0.0010-0.0014 inch thick oriented polypropylene meets the performance criteria of this specification. For the lidding material for the HFFS **SSP** pouch, it has been found that a material structure consisting of, from inside to outside 0.003 to 0.004 inch thick polyolefin, 0.00035 to 0.0007 inch thick aluminum foil and 0.0005 to 0.00075 inch thick polyester meets the performance criteria of this specification. The above values and ranges expressed for the thickness of thin gauge plastic films and aluminum foil are nominal values. A plus or minus 20% tolerance is typical for thin gauge plastic film thickness measurements and a plus or minus 10% tolerance is typical for aluminum foil thickness measurements.

**6.2.2 Type II pouch material.** The U.S. Army Soldier Biological and Chemical Command (SBCCOM), Natick Soldier Center (NSC) has found that for preformed ISP pouches, a material 5-layer structure consisting of, from inside to outside, 0.004 inch thick polyolefin, 0.00098 inch thick biaxially oriented polyamide, 0.00035 inch thick aluminum foil, 0.00059 inch thick biaxially oriented polyamide, and 0.00047 inch thick polyester meets the performance criteria of this specification. The above values and ranges expressed for the thickness of thin gauge plastic films and aluminum foil are nominal values. A plus or minus 20% tolerance is typical for thin gauge plastic film thickness measurements and a plus or minus 10% tolerance is typical for aluminum foil thickness measurements.

## **6.3 Carton design and material.**

**6.3.1 Type I Carton design and material.** The SSCOM (NRDEC) has found that a **SSP** carton design and material conforming to variety I, style I, type A, class a or style XIV, group I or II of PPP-B-566, Boxes, Folding, Paperboard, except that the carton may be made of 16-point bending chips, kraft lined chips or unbleached solid sulfate paperboard or of 17-point low density kraft paperboard having a minimum basis weight for the bending chips and the kraft lined chipboard of 60 pounds per 1000 square feet, a minimum basis weight for the unbleached solid sulfate board of 55 pounds per 1000 square feet or a minimum basis weight for the low density kraft paperboard of 48 pounds per square feet meets the performance criteria of this specification. The use of materials composed of the highest percentage of recovered materials practicable is encouraged by the Resource Conservation and Recovery Act of 1976.

**6.3.2 Type II Carton design and material.** It has been found that a ISP carton constructed of grade 275 fiberboard in accordance with ASTM D 5118, oriented with flutes parallel to the carton width, jointed and hot melt glued along either the vertical length or bottom face of the carton, and then ends closed and compressed and securely taped across the open ends of the carton at their midpoints meets the performance criteria of this specification.

**6.4 Technical information.** Specific technical inquiries may be addressed to the Commander, U.S. Army Soldier Systems Biological Chemical Command, Natick Soldier Center, ATTN: AMSSB-RCF-F(N), 15 Kansas Street, Natick, MA 01760-5018.

**6.5 Subject term (key word) listing.**

Meal, Ready-to-Eat

MRE

Operational rations

**Institutional Size Pouch (ISP)**

**6.6 Changes from previous issue.** Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

**Custodians:**

Army - GL  
Navy - SA  
Air Force - 35

**Preparing activity:**

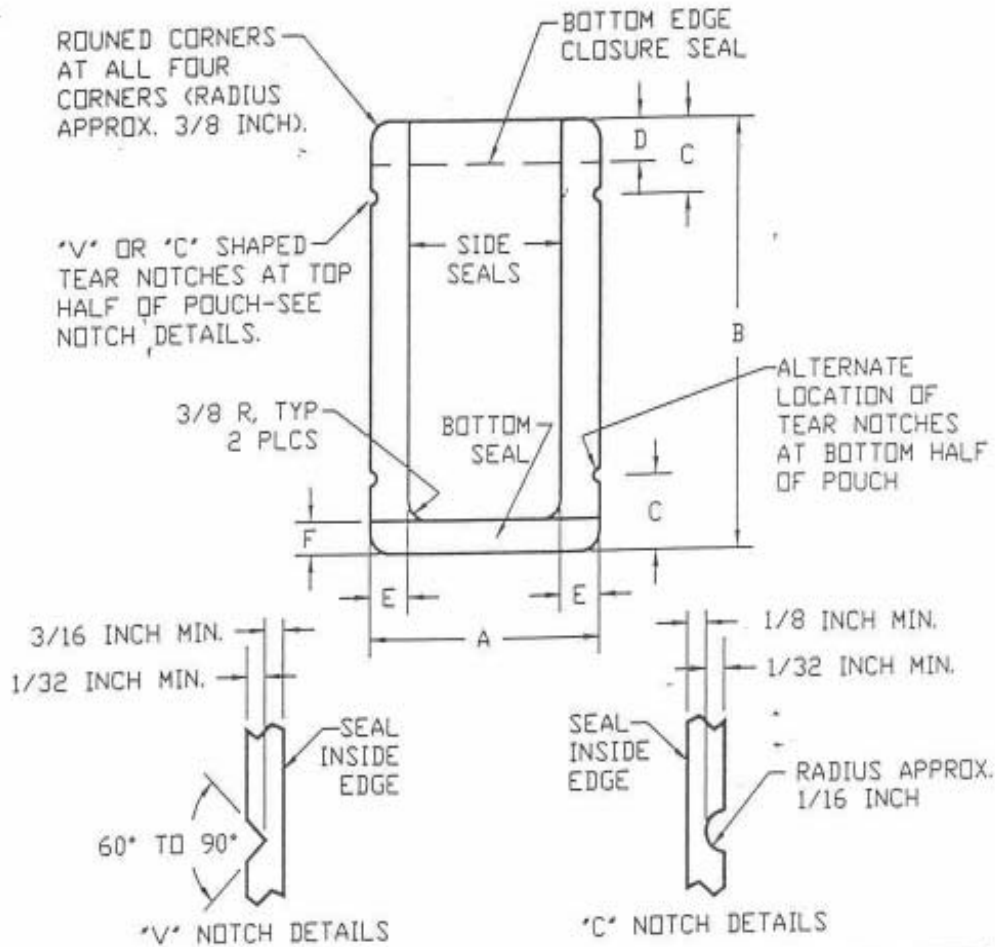
Army - GL  
(Project 89GP-A003)

**Review activities:**

Army - MD, QM  
Navy - MC  
DLA - SS

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POUCH SIZES	DIMENSIONS IN INCHES					
	A	B	C	D	E	F
5 OUNCE SIZE 1/	4 3/4 (± 1/16)	6 1/16 TO 6 1/4	1 (± 1/16)	3/4 MAX.	7/32 MIN.	1/8 MIN.
		6 1/4 TO 7 3/8	1 1/2 ± 1/16	1 MAX		
PRIMARY 1/8 8 OUNCE SIZE	4 3/4 (± 1/16)	8 1/8 (+ 1/8 - 1/16)	1 1/2 (± 1/16)	1 MAX	7/32 MIN.	1/8 MIN.
ALTERNATE 1/8 8 OUNCE SIZE	5 1/4 (± 1/16)	7 1/4 (+ 1/8 - 1/16)	1 1/2 (± 1/16)	1 MAX	7/32 MIN.	1/8 MIN.

NOTES: 1. ALL FIVE OUNCE SIZE POUCHES HAVING A "B" DIMENSION OF MORE THAN 6 1/4 INCHES AND ALTERNATE EIGHT OUNCE SIZE POUCHES SHALL HAVE A SECOND SET OF NOTCHES LOCATED NOT LESS THAN 2 5/8 OR MORE THAN 3 1/16 INCHES FROM THE END OF THE POUCH USED TO LOCATE THE SET OF NOTCHES ILLUSTRATED ABOVE. ALL PRIMARY EIGHT OUNCE SIZE POUCHES SHALL HAVE A SECOND SET OF NOTCHES LOCATED 3 ± 1/16 INCHES FROM THE END OF THE POUCH USED TO LOCATE THE SET NOTCHES ILLUSTRATED ABOVE.

FIGURE 1

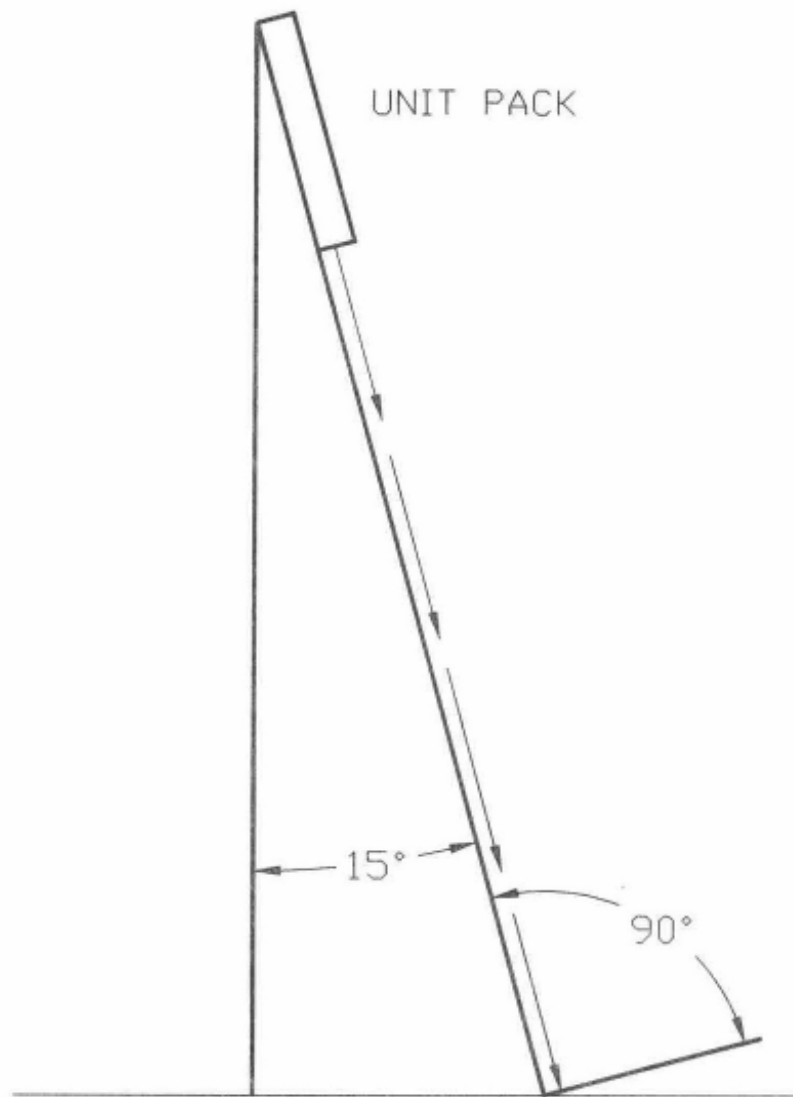


FIGURE 2  
POUCH ABUSE TEST APPARATUS

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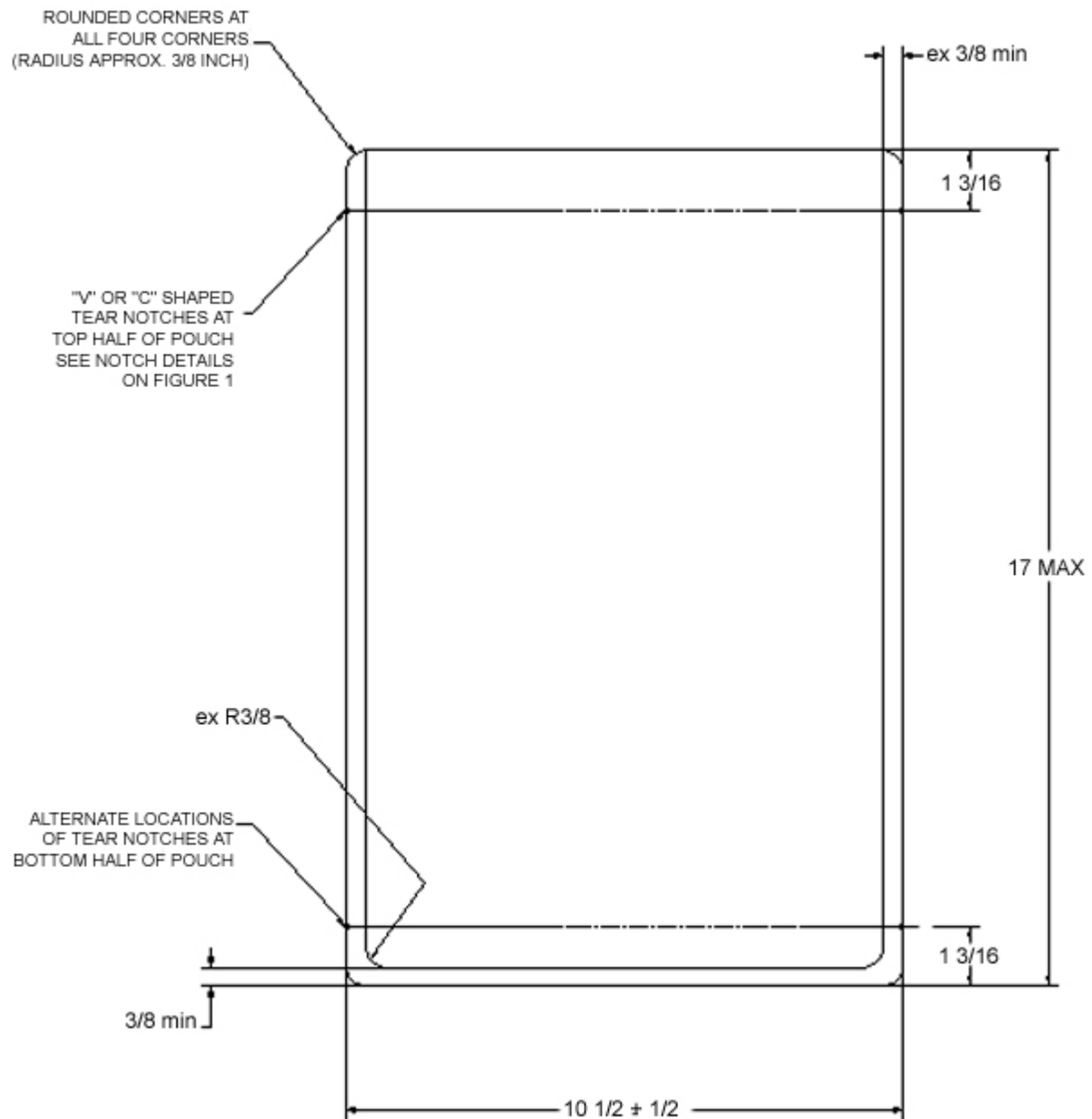


FIGURE 3. Institutional Size Pouch  
(Not actual size)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL		
INSTRUCTIONS		
<p>1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.</p> <p>2. The submitter of this form must complete blocks 4, 5, 6, and 7, and send to preparing activity.</p> <p>3. The preparing activity must provide a reply within 30 days from receipt of the form.</p> <p><b>NOTE:</b> This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.</p>		
<b>I RECOMMEND A CHANGE:</b>	<b>1. DOCUMENT NUMBER</b> MIL-PRF-44073F	<b>2. DOCUMENT DATE (YYYYMMDD)</b> 2001 09 04
<b>3. DOCUMENT TITLE</b>  PACKAGING OF FOOD IN FLEXIBLE POUCHES		
<b>4. NATURE OF CHANGE</b> ( <i>Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.</i> )		
<b>5. REASON FOR RECOMMENDATION</b>		
<b>6. SUBMITTER</b>		
a. NAME ( <i>Last, First, Middle Initial</i> )	b. ORGANIZATION	
c. ADDRESS ( <i>Include ZIP code</i> )	d. TELEPHONE ( <i>Include Area Code</i> ) (1) Commercial  (2) DSN ( <i>If applicable</i> )	<b>7. DATE SUBMITTED</b> (YYYYMMDD)
<b>8. PREPARING ACTIVITY</b>		
a. NAME US Army Soldier & Biological Chemical Command Natick Soldier Center	b. TELEPHONE (Include Area Code) (1) Commercial 508-233-5907 (2) DSN 256-5907	
c. ADDRESS ( <i>Include ZIP code</i> ) US Army Soldier & Biological Chemical Command Natick Soldier Center Attn: AMSSB-RCF-FN 15 Kansas Street Natick, MA 01760-5018	<b>IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:</b> Defense Standardization Program Office (DLSC-LM) 8725 John J. Kingman Road, Suite 2533 Fort Belvoir, Virginia 22060-6221 Telephone (703) 767-6888 DSN 427-6888	